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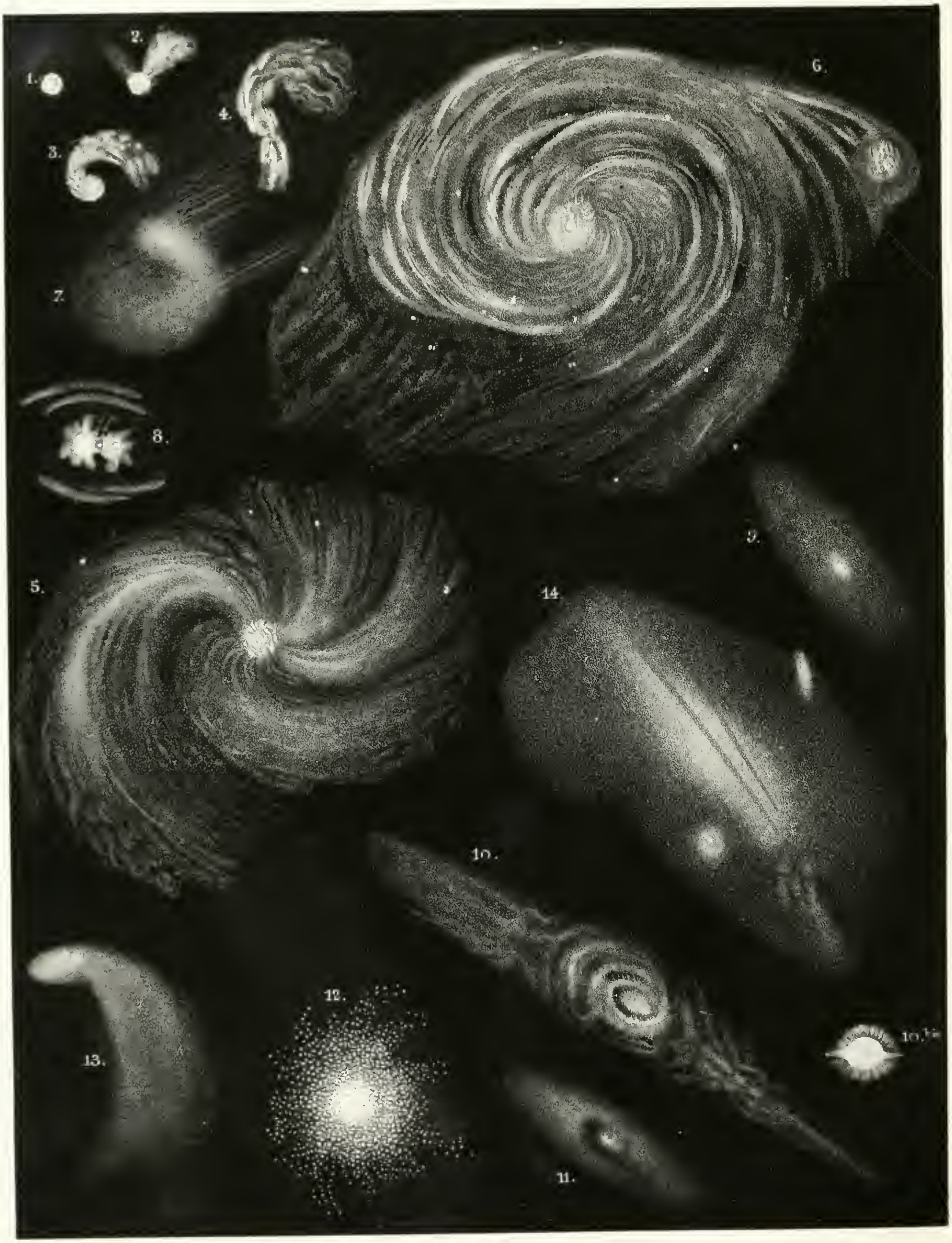
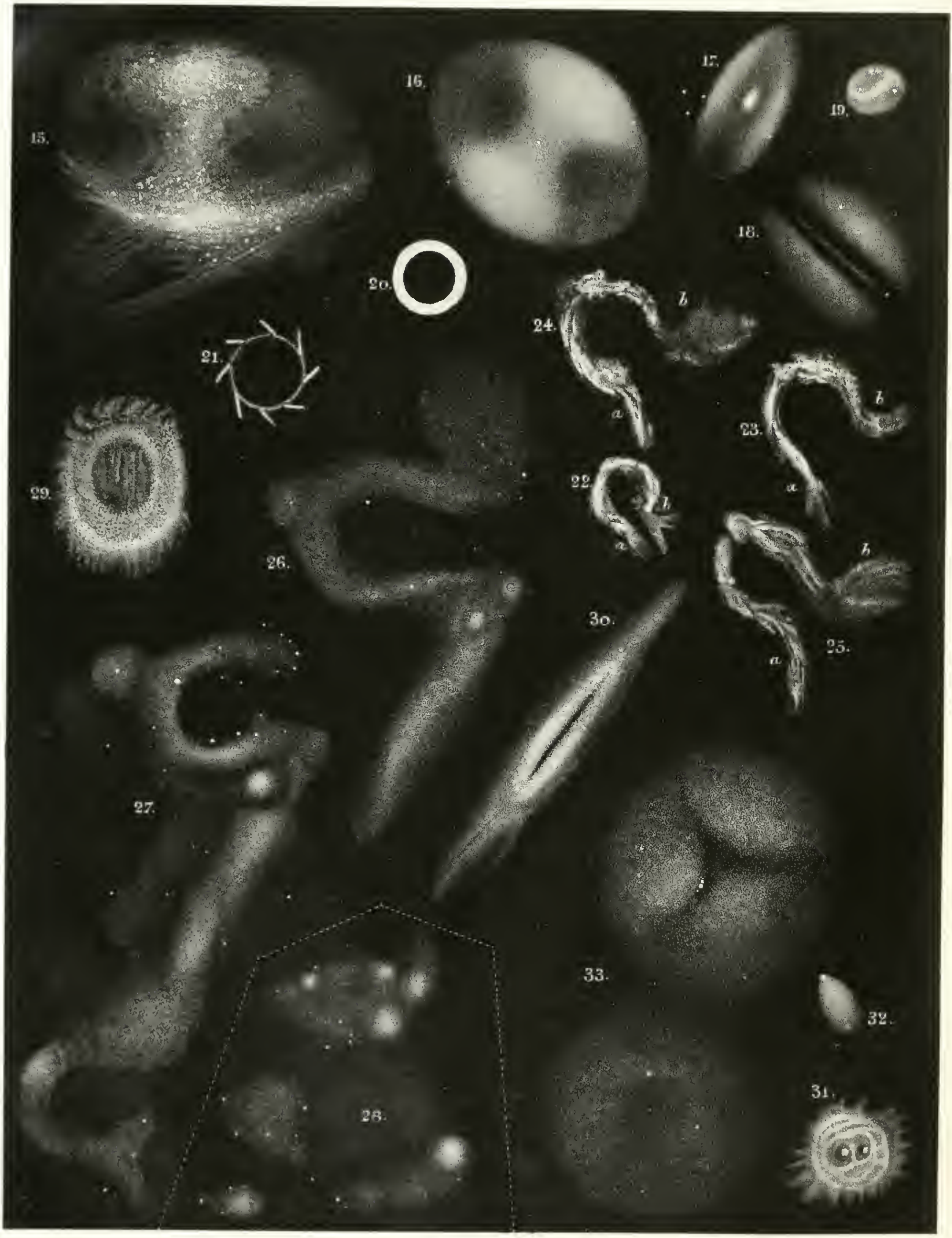


ASTRONOMICAL JOURNAL VOL. II. PL. I.



ASTRONOMICAL JOURNAL VOL. II. PL. 2.

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THE
ASTRONOMICAL JOURNAL.

EDITED BY

BENJ. APTHORP GOULD, Jr.,

PH. DR., FELLOW OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES, OF THE AMERICAN PHILOSOPHICAL SOCIETY AT PHILADELPHIA, ETC.

VOLUME II.

MAY, 1851, TO SEPTEMBER, 1852.

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THE

ASTRONOMICAL JOURNAL.

No. 25.

VOL. II. CAMBRIDGE, 1851, MAY 2. NO. 1.

OBSERVATIONS OF EGERIA AND METIS.

By PROFESSOR CHARLES RÜMKER.

DIRECTOR OF THE HAMBURG OBSERVATORY.

[Not corrected for parallax.]

EGERIA.

Date.	Hamburg M. T.	α	δ
	h. m. s.	° ′ ″	° ′ ″
1850, Nov. 14	12 36 28.3	27 20 27.5	+ 8 21 58.0
15	7 18 10.7	27 9 38.5	8 24 1.7
15	10 10 5.9	27 7 52.5	8 24 21.7 Mer. Cir.
16	7 0 29.4	26 56 8.7	8 26 28.3
20	9 24 39.0	26 3 31.6	8 37 48.4
25	9 22 8.2	25 8 2.7	8 54 11.4
26	6 59 15.4	24 59 12.0	8 57 18.4
26	9 18 11.2	24 58 16.9	8 57 48.8 Mer. Cir.
28	6 12 22.6	24 40 53.2	9 4 30.4
29	8 56 44.0	24 31 12.2	9 8 49.5*
30	6 16 4.5	24 23 42.3	9 12 43.1
Dec. 16	8 21 33.8	23 13 38.4	10 30 30.1*
17	5 45 8.6	23 13 14.0	+10 35 35.6
1850, Dec. 26	6 52 39.5	23 27 27.6	+11 31 38.8
31	7 5 40.9	23 49 49.5	12 5 46.5*
1851, Jan. 22	8 4 30.8	27 17 3.1	14 58 6.1
28	7 11 54.8	28 39 19.6	15 49 10.9
31	7 55 37.6	29 24 55.2	16 16 3.2
Feb. 1	7 18 22.7	29 40 10.0	16 24 37.2*
6	8 29 46.2	31 2 14.6	17 9 32.9
21	8 17 54.6	35 41 24.0	19 27 18.3*
23	7 28 13.3	36 21 34.8	19 45 34.0*
24	8 29 24.0	36 43 3.8	19 55 4.1
26	8 36 46.2	37 25 3.6	20 13 37.0*
27	8 4 33.7	37 45 48.0	20 22 38.2*
Mar. 2	7 54 25.6	38 50 44.9	+20 50 35.8*

The observations marked with a * are especially reliable.

Mean Places, 1851.0, *of Comparison-Stars.*

α	δ	α	δ	α	δ	α	δ
h. m. s.	° ′ ″	h. m. s.	° ′ ″	h. m. s.	° ′ ″	h. m. s.	° ′ ″
1 29 12.266	11 22 40.1	1 35 13.099	12 9 9.3	1 46 17.541	8 51 51.0	1 52 52.127	8 29 15.3
1 29 45.292	11 18 59.6	1 35 41.684	12 7 47.8	1 46 31.401	8 48 —	1 53 3.591	15 50 33.0
1 30 14.360	12 5 9.0	1 38 ——	8 24 22.3	1 46 56.984	8 27 27.5	1 54 42.676	8 21 38.4
1 31 58.113	7 38 50.2	1 40 41.914	9 28 12.6	1 50 34.056	15 12 9.2	1 58 27.664	16 22 12.1
1 33 31.801	8 19 1.5	1 42 25.615	9 4 8.6	1 52 27.044	8 39 43.1	2 1 12.377	16 31 24.2
1 34 18.763	10 35 48.7	1 44 45.841	8 50 58.4				

METIS.

Date. 1851.	Hamburg M. T.	α	δ
	h. m. s.	° ′ ″	° ′ ″
Feb. 7	8 30 34.7	144 27 3.5	24 3 54.7
9	7 32 13.4	143 56 10.3	24 15 17.7
10	8 6 11.2	143 40 7.8	24 20 5.8
11	6 57 34.0	143 25 16.1	24 26 4.6
13	7 21 50.3	142 53 50.5	24 36 18.3
14	7 19 57.2	142 38 28.7	24 41 4.7
17	7 20 42.4	141 52 51.5	24 51 29.5
21	9 16 18.3	140 53 54.7	25 9 25.0
Feb. 23	9 11 5.6	140 26 29.5	25 15 21.5
24	9 17 45.7	140 13 13.0	25 18 3.3
26	10 54 29.6	139 46 52.6	25 22 57.0 Mer.
27	10 49 45.1	139 34 47.1	25 24 54.1 Mer.
Mar. 2	10 35 41.8	139 0 42.2	25 29 35.9 Mer.
10	9 59 27.4	137 48 42.7	25 32 24.9 Mer.
19	9 21 8.2	137 4 35.6	25 20 40.4 Mer.
22	9 8 57.1	136 58 13.8	25 13 37.0 Mer.

Mean Places, 1851.0, of Comparison-Stars.

α	δ	α	δ
h. m. s.	° ′ ″	h. m. s.	° ′ ″
9 15 37.454	25 5 25.3	9 22 55.483	25 4 1.8
9 21 30.309	25 19 15.8	9 29 2.521	25 3 46.3

OBSERVATIONS OF CLIO.

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By Mr. JAMES FERGUSON.

Communicated by Lieutenant MAURY, Director of the Observatory.

[Corrected for refraction.]

Date.	M. T. Washington.	No. of Comp.	Comparison Star.	⚘ — * Δα	⚘ — * Δδ	⚘'s apparent α	⚘'s apparent δ	A.
	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″	
1850, Oct. 28	10 11 13.7	10	*a*	—1 41.69	— 5 45.89	23 23 18.63	+6 35 47.37	8
29	8 41 58.6	10	Santini 1636	—1 11.02	+12 51.93	23 26.60	28 46.35	9
	9 16 40.4	4	*a*	—1 36.24	—12 51.41	23 27.05	28 41.91	9
31	7 39 36.4	14	Santini 1636	—0 48.11	— 0 59.31	23 49.19	14 52.06	10
	10 13 1.8	4	"	—0 47.01	— 1 42.46	23 50.61	14 8.91	10
Nov. 1	7 33 40.9	14	"	—0 34.08	— 7 42.03	24 3.52	8 9.33	10
	8 28 51.9	6	"	—0 33.59	— 7 57.11	24 4.00	7 51.25	10
2	8 15 7.6	5	"	—0 17.53	—14 24.55	24 20.08	1 26.79	9
	9 0 1.5	5	"	—0 17.25	—14 36.47	24 20.15	6 1 14.87	9
4	8 16 7.7	11	*b*	—0 37.28	—12 48.11	24 57.96	5 49 9.24	9
	8 53 47.7	5	"	—0 36.56	—12 58.21	24 58.68	48 59.15	9
5	7 48 52.7	4	B. A. C. 8177	+1 51.42	+ 9 46.38	25 18.56	43 26.84	8
	7 52 26.8	6	Weisse XXIII. 458	+2 32.02	+ 7 8.44	25 18.73	43 25.91	8
(1) 9	8 18 33.3	12	" 534	+0 45.13	+14 5.54	27 1.22	22 39.27	8
		12	" 602	—2 10.82	+17 2.23	27 1.58	22 36.27	8
10	7 19 34.4	4	" 534	+1 13.72	+ 9 40.79	27 29.79	18 14.50	7
		4	" 602	—1 41.94	+12 36.62	27 30.16	18 10.58	7
	8 7 15.8	5	" 534	+1 14.96	+ 9 30.24	27 31.04	18 3.95	7
		5	" 602	—1 41.15	+12 26.86	27 31.26	18 0.83	7
13	7 39 24.7	20	" 602	—0 3.35	+ 0 14.80	29 9.00	5 48.66	8
14	7 37 29.5	12	" 602	+0 32.870	— 3 23.35	29 45.22	5 2 10.59	9
18	7 20 3.7	20	B. A. C. 8233	+0 6.36	+ 0 54.42	32 21.16	4 49 58.93	6
21	8 40 47.0	10	"	+2 22.32	— 5 54.70	34 38.27	43 9.66	8
24	7 39 42.7	10	Weisse XXIII. 803	—2 22.11	+13 10.35	37 2.61	38 29.50	8
30	6 51 56.7	7	" 803	+3 1.90	+ 9 23.85	42 26.55	34 41.62	8
		7	" 934	—3 8.10	+15 2.83	42 26.63	34 45.28	8
Dec. 8	6 41 38.9	17	" 1032	+0 25.65	+ 6 6.96	50 35.42	40 36.79	7
9	6 47 41.1	10	" 1032	+1 31.89	+ 7 42.70	51 41.65	42 12.32	7
11	8 46 1.2	6	" 1032	+3 52.15	+11 29.81	54 1.91	45 59.43	8
	8 42 15.2	5	" 1045	—3 17.15	— 3 13.11	23 54 1.81	4 45 58.12	8
20	8 17 44.8	13	Weisse O. 83	—0 19.98	—10 43.53	0 4 48.25	5 10 4.57	8
21	6 49 59.6	12	" 83	+0 50.90	— 7 30.30	5 59.12	13 17.19	8
24	9 20 17.7	7	" 210	—2 26.40	— 3 4.65	9 58.57	24 42.53	10
26	8 52 8.7	15	" 210	+0 9.46	+ 4 56.44	12 34.40	32 43.44	10
27	7 16 10.8	12	" 210	+1 24.14	+ 8 41.52	13 49.08	36 28.46	6
1851, Jan. 1	8 2 50.0	6	B. A. C. 129	—4 2.59	— 8 37.29	20 39.19	5 59 9.78	7
12	7 15 6.9	5	Weisse O. 638	—0 22.03	— 2 57.67	36 20.68	6 57 30.61	9
	7 30 18.8	13	" 635	—0 14.75	+ 0 17.90	36 21.85	6 57 38.06	9
13	7 20 2.6	17	" 657	—0 6.96	+ 1 47.52	0 37 49.89	+7 3 24.23	10

(1) The observations preceding the 9th November have already been published, Vol. I. p. 150.

Date.	M. T. Washington.	No. of Comp.	Comparison Star.	♅ − *		♅'s apparent		A.
				Δα	Δδ	α	δ	
	h. m. s.			m. s.	′ ″	h m. s.	° ′ ″	
1851, Jan. 14	7 15 10.3	3	Weisse O. 657	+1 22.31	+ 7′ 37″.03	0 39 19.15	+7° 9′ 13″.66	4
16	6 50 37.1	2	“ 680	+3 6.73	− 8 20.05	42 16.04	7 21 5.11	4
24	8 35 24.9	7	“ 965	−0 18.38	− 7 27.42	54 37.00	8 12 18.33	7
25	8 12 23.1	6	“ 965	+1 13.43	− 1 0.50	0 56 8.80	18 45.01	7
31	6 53 37.1	10	Weisse I. 100	−1 31.76	+ 1 53.14	1 5 31.10	58 52.16	8
		10	“ 113	−2 27.64	− 0 38.70	5 31.24	8 58 51.37	8
Feb. 6	6 59 35.3	6	“ 299	−2 57.18	+ 3 5.46	15 9.67	9 40 45.78	8
11	6 55 1.4	13	“ 382	+0 52.71	− 2 41.87	23 18.57	10 16 22.13	8
12	6 52 21.5	6	“ 382	+2 31.32	+ 4 25.31	24 57.16	23 29.53	10
16	6 57 28.9	11	“ 569	−0 49.23	+14 51.40	31 35.54	52 23.97	10
17	6 53 50.5	8	“ 569	+0 49.96	− 7 37.99	33 14.71	10 59 37.26	10
18	7 42 1.5	4	“ 569	+2 33.43	− 0 13.80	34 18.17	11 7 1.34	8
22	7 9 2.3	16	“ 740	+0 25.24	− 2 45.68	41 37.84	35 51.48	10
25	7 8 21.6	7	“ 855	−0 57.34	+ 7 24.25	46 42.50	57 40.09	10
	7 51 29.8	3	“ 855	−0 51.07	+ 7 36.60	46 45.76	11 57 52.44	10
Mar. 1	7 31 33.7	10	“ 943	+0 45.03	−12 39.18	53 32.71	12 26 48.82	10
2	7 6 14.3	4	“ 943	+2 25.51	− 5 36.10	55 13.18	33 50.87	10
	7 22 34.1	12	“ 973	+0 41.40	−11 14.40	55 14.50	33 55.91	10
3	7 17 14.7	7	“ 973	+2 23.87	− 4 3.64	56 56.95	41 6.63	9
4	7 32 5.5	12	“ 1042	+0 14.27	+ 3 37.83	1 58 40.91	12 48 23.42	10
9	7 17 51.1	1	Weisse II. 64	+2 22.38	− 8 15.35	2 7 15.90	13 24 2.53	10
10	7 10 52.5	12	“ 143	−0 55.17	−15 14.39	9 2.18	31 12.45	10
11	7 19 52.4	8	“ 143	+0 49.18	− 8 10.40	10 46.53	38 16.40	8
13	7 11 45.0	6	“ 182	+2 8.42	+15 42.51	14 15.50	13 52 12.55	10
21	7 53 14.7	4	“ 479	−0 13.35	+15 56.86	28 17.15	14 47 29.35	8
24	7 44 37.7	4	“ 556	+1 10.76	+ 5 9.46	33 36.83	15 7 38.10	10
25	7 21 46.5	4	“ 569	+2 17.35	− 9 33.27	2 35 22.21	+15 14 13.80	10

Adopted Mean Places, 1850.0, *of Comparison-Stars.*

*	Mag.	α	δ	Authority.	No. of Comp.
		h. m. s.	° ′ ″		
Weisse XXIII. 452	9	23 22 18.15	+6 59′ 39″.86	Weisse's Catalogue.	
a	9.10	23 25 0.74	6 41 13.66	Washington Equatorial, from Weisse 452.	7
Santini 1636	7.8	23 24 35.10	6 15 31.83	Santini's Catalogue. Memoirs R. A. S.	
b	9.10	23 25 32.76	6 1 37.97	Washington Equatorial, from Santini 1636.	10
B. A. C. 8177	5	23 20 21.69	5 33 21.10	B. A. Catalogue.	
Weisse XXIII. 458	8.9	23 22 44.27	5 35 58.17	Weisse's Catalogue.	
“ 534	9	23 26 13.64	5 8 14.75	“ “	
“ 602	9	23 29 9.94	5 5 15.16	“ “	
Greenwich 12 Y. C. 2119	4.5	23 32 13.43	4 48 46.09	Greenwich 12 Year Catalogue.	
Weisse XXIII. 803	9	23 39 22.37	4 25 1.31	Weisse's Catalogue.	
“ 934	9	23 45 32.43	4 19 25.17	“ “	
“ 1032	9	23 50 7.53	4 34 13.09	“ “	
“ 1045	9	23 50 42.43	4 48 54.62	“ “	
Weisse O. 83	9	0 5 6.02	5 20 31.80	“ “	
“ 210	9	0 12 22.76	5 27 31.87	“ “	
B. A. C. 129	9	0 24 39.56	6 7 32.51	Santini's Catalogue. Memoirs R. A. S.	
Weisse O. 635	8.9	0 36 34.46	6 57 6.54	Weisse's Catalogue.	
“ 638	9	0 36 40.56	7 0 14.62	“ “	
“ 657	8	0 37 54.70	7 1 23.18	“ “	
“ 680	9	0 39 7.19	7 29 11.83	“ “	
“ 965	7	0 54 53.24	8 19 33.22	“ “	
Weisse I. 100	8	1 7 0.73	8 56 47.23	“ “	
“ 113	7	1 7 56.75	8 59 18.33	“ “	
“ 299	8	1 18 4.73	9 37 29.16	“ “	
“ 382	9	1 22 23.77	10 18 53.15	“ “	
“ 569	9.10	1 32 22.67	11 7 4.88	“ “	
“ 740	9	1 41 10.70	11 38 27.84	“ “	
“ 855	9	1 47 37.76	+11 50 6.48	“ “	

*	Mag.	α	δ	Authority.	No. of Comp.
		h. m. s.	° ′ ″		
Weisse I. 943	8.9	1 52 45.62	+12 39 18.82	Weisse's Catalogue.	
" 973	7	1 54 31.03	12 45 1.20	" "	
" 1042 Rümker 533	7.8	1 58 21.58	12 44 36.67	Rümker's Catalogue.	
Weisse II. 64	9	2 4 51.43	13 32 9.52	Weisse's Catalogue.	
" 143	8	2 9 55.29	13 46 18.65	" "	
" 182	8.9	2 12 5.04	13 36 22.53	" "	
" 479	9	2 28 28.07	14 31 25.42	" "	
" 556	9	2 32 24.03	15 2 21.79	" "	
" 569	9	2 33 2.82	+15 23 40.13	" "	

During these observations, marked changes were observed in the apparent magnitude of this asteroid. On the night of the 4th of November it was of the same appearance as the star *b*, with which it was compared. On the succeeding night, with but slight change of atmosphere, it had diminished to the 12 magnitude. This change cannot be attributed to any general or partial change of atmosphere, for the star *b*, still near it, and also *Hygea*, which was observed on the same nights and nearly at the same times, exhibited no perceptible change. Differences to a greater amount were observed between the 22d and 25th of February, and between the 1st and 4th of March. At these times, stars in the same vicinity, and nearly of the same magnitude as *Clio*, were compared with it each night. A peculiarity noted in the observations of March is, that the planet had its brightest aspect in the most unfavorable atmosphere, although in this respect the difference was not a great one.

Similar differences of magnitude in the other asteroids have been noticed at this Observatory, particularly in *Astræa*.

At the last two observations (the 24th and 25th of March), *Clio* was barely visible with the slightest illumination. It was sought for on the 3d and 9th of April without success.

LETTERS FROM PROFESSOR HUBBARD TO THE EDITOR.

Observatory, *Washington*, 1851, *April* 11.

I HAVE just computed the following orbit for *Egeria*, from observations by Mr. FERGUSON, December 28, February 27, and March 26.

Epoch 1851, January 1.0, M. T. Berlin.

M	296° 6′ 35″.94
ω	43 20 58.75
☊	78 45 58.65
i	16 34 48.31
ϕ	4 48 26.17
Log. μ	2.9372406
" a	0.4085107
" e	8.9232662

These elements give for the middle place

$$\Delta\lambda = -0''.35 \qquad \text{C.} - \text{O.} \qquad \Delta\beta = +0''.02$$

For the observation at Naples, November 3, the only other one with which I have yet compared them, they give

$$\Delta\alpha = +3'\ 45''.5 \qquad \Delta\delta = +6''.2$$

Washington, *April* 21.

LIEUTENANT GILLISS has sent me, under date of February 22, 1851, the following errors in the Catalogue of the British Association, and in that of LACAILLE: —

IN THE B. A. C.

No. 824. N. P. D. should be 164° 40′, instead of 164° 50′.
" 1116. Unsuccessfully sought three times.
" 1215. " " "
" 2065. Positively does not exist in this place.
" 2075. " " "
" 3387. The nearest star to this place is *L*. 4086, 1m. 30s. following, and 8′ south.
" 7481. Is not separated by our instrument, and cannot be 1″ distant if it is double.

IN LACAILLE'S CATALOGUE.

No. 292. P. D. 10′ less than given here.
No. 1723. Does not exist if so large as 10 magnitude.
" 1818. P. D. 4′ more than given. BRISBANE right.
" 3009. Does not exist.
" 3523. Does not exist. There is one star differing 30s. in R. A., and 6′ in P. D.
" 3745. Does not exist. There is a star differing 30s. in R. A., and 3′ in P. D.
" 3982. Does not exist.
" 4184. Does not exist. We find BRISBANE 2870.
" 7548. No star in this place so bright as 10 magnitude.
" 9392. P. D. 7′ more than given.
" 9743. P. D. 5′ more than given.

"You will understand," adds Lieutenant GILLISS, "that the errors of right-ascension and polar distance here given are rough, — the instrumental errors in no case being applied."

ON THE NEW RING OF SATURN.

By W. C. BOND, Esq.
DIRECTOR OF THE OBSERVATORY OF HARVARD UNIVERSITY.

I HAD intended not to have made any communication on the subject of the new interior ring of *Saturn*, until an engraving had been prepared to exhibit its position and appearance. However, as I have been disappointed in this respect, and our continued observations having placed the fact of the existence of the ring beyond question, I will now ask permission to communicate some extracts from our note-book.

The first diagram of the new interior ring of *Saturn* was made by G. P. Bond, on the night of the 11th of November, 1850. The memorandum in the note-book runs thus: —

" November 11th, 22$^{\text{h.}}$ 50$^{\text{m.}}$ sidereal time, (= 7$^{\text{h.}}$ 30$^{\text{m.}}$ mean solar time), very good definition. We notice to-night, with full certainty, the filling up of light inside the inner edge of the inner ring of *Saturn;* also, what is very singular, where the ring crosses the ball from *c* to *d* (referring to a diagram), or *below* the edge, there is a dark band, no doubt the shadow of the ring. But there is *also a dark line* from *a* to *b*, or above the ring, very plainly to be seen, as there can be no question of the line where the ring crosses the ball.

" The light which fills the corners of the inner ring at *x* and *y* is suddenly terminated on the side towards the ball. The light does not arise, I think, from any optical cause, for I cannot see why the same appearance should not be visible on the outside of the ring, or, indeed, of any object which we look at. Am very confident of having seen to-night a second division of the ring, near the inner edge of the inner ring."

" November 15th, 7$^{\text{h}}$ 30$^{\text{m.}}$. Examined the new ring of *Saturn* with different powers, best definition with 400. New ring sharply defined; edge next the ball. W. C. Bond thinks he sees the new ring clear of connection with the old, but the side next the old ring is not so definite as next the planet, so that it is not certain whether the new is connected with the old ring or not. Where the dusky ring crosses *Saturn*, it appears a little wider at the outside of the ball than in the middle. Where the new ring crosses *Saturn*, it appears not so dark as the shadow of the ring below on the body of the planet."

" 8 P. M. The best definition of *Saturn's* ring we have ever had. G. P. Bond examined with powers 140 and 400. Cannot be sure that the new ring is divided from the old one, but there can be no doubt that it exists; its inner edge is sharply defined. I did once or twice fancy, with the higher powers, that there was a division between the old and new rings. All the southern region of *Saturn* is dusky and striped with belts.

Outer diameter of outer ring	= 43″.9
Inner diameter of inner ring	= 29.3
Breadth of outer ring	= 2.3
Inner diameter of dusky ring	= 26.3
Distance of its inner edge from old ring	= 1.5

" According to Encke's measures, *Astr. Nach.*, No. 338, the inner diameter of the inner ring should be, at the above date, about 29″.8; whereas, by the above measures, we make the inner diameter of the new ring to be only 26″.3."

Our observations, continued to the 7th of January, fully confirmed the deductions which we had drawn from those of the 11th and 15th of November.

The same appearances were noticed by the Rev. W. R. Dawes, at his Observatory, near Maidstone, in England, on the 25th and 29th of November, and subsequently by Mr. Lassell, of Starfield, near Liverpool. An account of their observations is given in the Royal Astronomical Society's *Notices* for January 10th, 1851.

ON THE RINGS OF SATURN.

By G. P. BOND,
ASSISTANT AT THE OBSERVATORY OF HARVARD UNIVERSITY.

THE question of the multiple divisions of the ring of *Saturn* has engaged the attention of astronomers from an early period. Cassini appears to have been the first to notice the primary division, though he has placed it midway between the inner and the outer edges.

This interval is always visible with a good telescope, but much nearer to the outer edge than Cassini describes it to be. Short, next, with a telescope of twelve feet focus, probably a reflector, saw two or three divisions outside of the center of the ring; a figure is given in Lalande's Astronomy. In June, 1780, Sir W. Herschel noticed, on four different nights, a division near the inner edge. From its never, either previously or subsequently, having been seen by him, it is probable that the subdivisions are not permanent; otherwise they could scarcely have escaped detection under the scrutiny to which he subjected every thing appertaining to the system of *Saturn* for thirty or forty years. This inner division is figured and described in the *Philosophical Transactions* for 1792. In Gruithuisen's *Astron. Jahrbuch*, for 1840, pp. 103–105, mention is made of lines seen on both rings in 1813 and 1814.

Quetelet, at Paris, with an achromatic of ten inches' aperture, saw the outer ring divided in December, 1823.

On the 17th of December, 1825, and on the 16th and 17th of January, 1826, at least three divisions were seen on the outer ring by Captain Kater. A full account, illustrated with engravings, has been published in Vol. IV. Part II. of the Memoirs of the Royal Astronomical Society. This contains also a collection of the accounts of previous observers. Two reflectors of the Newtonian form were used, of between six and seven inches' aperture.

At Berlin, on the 25th of April, 1837, the outer ring was seen by Professor Encke, with perfect distinctness, divided into two nearly equal parts, and several divisions were recognized on the inner edge of the inner ring. The great equatorial of the Berlin Observatory was used with an achromatic eyepiece.

On the 28th of May, the place of the outer secondary interval was determined. The great optical capacity of the telescope, and the eminence of Professor Encke as an observer, give the highest value to these observations. They are found in the *Astr. Nachr.*, No. 338. No. 357 of the same volume has a notice of several divisions on both rings, seen by De Vico, at Rome, with the Equatorial of the Roman College, the object-glass of six inches, by Cauchoix. A letter from M. Decuppis, *Comptes Rendus*, Vol. VII., gives a description of several divisions seen at Rome, in May, June, and July, 1838.

On the 7th of September, 1843, a division of the outer ring was detected by Messrs. Lassell and Dawes, at Starfield. They employed a Newtonian reflector of nine inches' aperture; the details are to be found in Vol. VI. of the Monthly Notices of the Royal Astronomical Society.

The newly discovered inner ring of *Saturn* cannot properly be classed with the subdivisions of the old ring, as it lies within its inner edge.

We have, then, the best assurance in the number and reputation of those who have described the phenomena in question, that to set aside these appearances by referring them to some optical deception on the part of the observer, or to some defect in his instrument, is an explanation altogether insufficient and unsatisfactory. On the other hand, we know that some of the best telescopes in the world, in the hands of Struve, Bessel, Sir John Herschel, and others, have given no indication of more than one division, when the planet has appeared under the most perfect definition. The fact, also, that the divisions on both rings have not usually been visible together, and that the telescopes which have shown distinctly several intervals in the old ring have failed to reveal the new inner ring, while the latter is now seen, but not the former, may be taken as some evidence that the difference is not probably owing to any extraordinary tranquillity or purity of the atmosphere, nor to any peculiarly favorable condition of the eye or instrument, but rather to some real alterations in the disposition of the material of the rings.

Admitting this, the idea that they are in a fluid state, and within certain limits change their form and position in obedience to the laws of equilibrium of rotating bodies, naturally suggests itself. There are considerations to be drawn from the state of the forces acting on the rings which favor this hypothesis. For instance, on the assumption that the matter of which the ring is composed is in a solid state, we may compute for any point on its surface the sum of the attractions of the whole ring and of *Saturn*. The centrifugal force, generated by its rotation, may then be determined from the condition that the particle must remain on the surface. Now in the case of a solid ring, particles on the inner and outer edges must have the same period of rotation. This condition limits the breadth of the ring, for if it be found necessary for the inner and outer edges to have different times of rotation, this can be accomplished only by a division of the ring into two or more parts. In this way Laplace has inferred the necessity of there being several rings. From a more exact analysis, M. Plana, in the *Mem. Acad. Turin*, Vol. XXIV., concludes that more than one ring is not essential. The data which he assumed we now know to have been very wide of the truth, as regards the mass and thickness of the ring.

Bessel's last determination of the mass derived from the progressive motion of the line of apsides of the satellite *Titan*, which amounts to a very sensible quantity, makes that assumed by Plana at least thirty times too large. If Bessel's mass be received, the necessity of numerous rings can scarcely be questioned.

If the density of the ring be the same with that of *Saturn*, and its matter uniformly distributed with Bessel's mass $= \frac{1}{118}$ of *Saturn's*, its thickness, seen from the earth, would only subtend an angle of $\frac{1}{29}$ of a second of arc. It is a confirmation of the mass adopted, that this does not vary more from that derived from observation, than we can attribute without improbability to a difference of density between the ring and *Saturn*. Sir John Herschel states, *Outlines of Astronomy*, p. 315, that it cannot be so large as one twentieth of a second. In the *Astronomical Journal* for January, 1850, I have given as the result of observations with the Great Refractor at Cambridge, during the disappearance of the ring in 1848 – 49, a thickness not exceeding one hundredth of a second. We cannot suppose the mass to be greater than that assigned by Bessel, without also admitting a density much greater than that of *Saturn*, the smallest observed thickness already requiring a density more than three times that of the planet.

In the calculations which follow, I have supposed the mass of the ring not greatly to exceed $\frac{1}{118}$ of *Saturn*, and its thickness $\frac{1}{45}$ of a second. For the other elements I have used Struve's measurements.

The analysis of the attraction of the ring presents great difficulties. Laplace has taken as an approximation for a very narrow ring the attraction of a cylinder of infinite length, having for its base an ellipse. Plana takes account of the curvature by assuming the breadth to be very small compared with its radius. But if more than the first term is taken into account, the numerical calculations become very complicated. These difficulties may in part be avoided by taking account of the form of the surface only in the immediate neighborhood of the point attracted. In all the parts distant compared with the thickness, it is sufficient to suppose the whole mass collected in the plane of the center of the rings. This plane, considered as made up of parallel straight lines, attracts the particle by the sum of the attractions of its elements. The attraction of each line parallel to its length, y being its perpendicular distance from the radius joining the attracted particle with the center, and r and r' the distances of its extremities from the same point, will be $\left(\frac{1}{r} - \frac{1}{r'}\right) dy$.

From which the attraction of a plane surface is easily computed by quadratures. For the ring on the surface of which the attracted particle is, and for the two next adjacent, I have used LAPLACE's formula, *Mécanique Céleste*, Vol. II. [2092]. This assumes the figure of the surface to be elliptical; in the absence of any certain knowledge of its form, this has the recommendation of simplicity and of satisfying also the conditions of equilibrium. The hypothesis of any other figure would not materially affect the conclusions arrived at, provided the mass and density be not altered. The numbers thus obtained are only approximations to the truth, but are sufficient for the object in view.

If we adopt for unity the radius of the outer edge of the outer ring, we have from observation the thickness of the ring $= 2\,b < \frac{1}{900}$. Let r and r' be the radii of the inner and outer edges, and i the interval between two adjacent rings,

$$r_0 = \frac{r + r'}{2},\ 2\,a = r' - r.$$

Any intervals permanently existing so large as one half, or even one third, of that usually seen, could not escape observation. Moreover, if the subdivisions are numerous, the width of the intervals must be proportionally diminished, because the whole area occupied by them goes to diminish the amount of light reflected, and to increase the density of each ring, both of which are already large. The light of the ring being sensibly brighter than that from an equal area on the ball, it is not probable that any considerable part of the light of the sun is transmitted through intervals. And to preserve the same mass, if the intervals are large, the matter must be compressed, as it is not allowable to give a thickness greater than is indicated by observation. To avoid the hypothesis of a reflective power, and a density greater than we are warranted in assuming, we must, therefore, consider the intervals to be very narrow. We may take, then, the width of all but the known interval as certainly less than 0.01, which is one half of the width of the known interval. From the blackness of the shadow of the ring upon the ball, which would be diminished in intensity were a considerable part of the sun's rays transmitted, we may infer that the intervals which reflect no light at all cannot occupy an area so large as one fourth of the average breadth of the rings; that is, $r' - r > 0.04$.

The above are very liberal allowances, but it is important to assume the intervals as large as possible, so as to diminish the chances of a collision, which at best is almost inevitable.

We come now to consider the forces acting on the rings.

If f' be the force with which a particle at the outer extremity of the major axis of a ring is attracted to its surface by the sum of the attractions of all the rings, f the same force for the inner edge, s the mass of *Saturn*, and t the time of revolution of any ring in days, the centrifugal force at the distance r will be $= \frac{k\,r}{t^2}$, log. $k = 9.1207$.

Then, in order that the particle should remain on the surface, we must have

$$f > \frac{s}{r^2} - \frac{k}{t^2}\,r\,;\ \ f > \frac{k\,r'}{t^2} - \frac{s}{r'^2}.$$

Therefore,

$$r' - r < \frac{r_0^3}{3\,s}\,(f + f).$$

If we put $F = \frac{s}{r_0^2} =$ the attraction of *Saturn* on the middle of any ring, we obtain the relation,

$$\frac{f + f'}{F} > 3\,\frac{r' - r}{r_0}.$$

From the smallness of the mass of the ring, as well as from its unfavorable distribution, it is easy to see that $r' - r$ must be very small compared with r_0.

To obtain f and f', I have computed from LAPLACE's formula the following values: f_0 is the attraction of a single ring upon a particle on its surface, at the extremity of the major axis of its base; f_1 and f_2 the attractions of the two next adjacent. The interval between $= 0.01$, $2\,b = \frac{1}{900}$. The radius of the outer edge of the outer ring being $= 1$.

Attractions of Three Narrow Rings.

	f_0	$\frac{f_1}{f_0}$	$\frac{f_2}{f_0}$
$a = 0.01$	+0.00661	−0.284	+0.134
.02	679	.393	.150
.03	685	.460	.154
.04	689	.507	.157
.05	691	.543	.160
.06	692	.571	.162
.07	693	.594	.164
.08	693	.614	.165
.09	694	.631	.166
.10	+0.00694	−0.646	+0.166

The attraction of the whole ring, considering its mass to be uniformly distributed, I have next computed by quadratures. Breadth of whole ring $= 0.335$. Radius of outer edge $= 1$.

Distance of particle within the outer edge $=$	0.0075	Attraction $=$	$+4.52 \times$ mass of ring.
" " " "	.0475	"	2.42
" " " "	.0875	"	1.70
" " " "	.1275	"	1.16
" " " "	.1675	"	0.61
" " " "	.2075	"	$+0.04$
" " " "	.2475	"	-0.52
" " " "	.2875	"	1.32
" " " "	.3275	"	-3.53

These two tables give the means of finding f and $\mathfrak{f}$ with sufficient exactness. For *Saturn* we have

$$S = \tfrac{4}{3}\pi\left(\frac{17\;.7}{40''.095}\right)^3;\ \log.\ S = 9.5567;$$

$$\log.\ \text{mass of ring} = 7.4848.$$

The density of the ring is assumed $=$ *Saturn's*, unless it be otherwise stated. A change in the density affects only that part of the ring's attraction depending on f_0, f_1, and f_2.

But $f + \mathfrak{f}$ will be changed very nearly in the direct ratio of the different densities when the rings are narrow.

We will first suppose the case of but one ring without division.

$$r = 0.665$$
$$r' = 1.000$$
$$r_0 = 0.8325$$
$$r' - r = 0.335$$

Upon a particle at a distance within the outer edge $= 0.21$, the attraction of the whole ring becomes $= 0$. This gives for the time of rotation $t = 0.43$. The excess of *Saturn's* attraction over the centrifugal force at the inner edge $= 0.37$. At the outer edge the centrifugal force is in excess by 0.33. We must therefore have, —

$f > 0.37$ and $\mathfrak{f} > 0.33$

But $f = 0.0040$ and $\mathfrak{f} = 0.0070$

Assumed value of $r' - r = 0.335$

Required " < 0.0058

If there be but one ring, it will be necessary to increase its attractive force by sixty times its probable value, in order to retain its particles on its surface.

With a single division into two equal rings, we have for the inner of the two, giving such a time of rotation as will retain particles on the middle from leaving their place,

$t = 0.39$ $r = 0.665$ $f > 0.25$ $\mathfrak{f} > 0.19$

$r' = 0.8325$ $f = 0.0050$ $\mathfrak{f} = 0\,0042$

$r' - r = 0.1675$ $r' - r$ computed $= 0.0036$

For the outer ring,

$f = 0.0012$ $\mathfrak{f} = 0.0081$

$r' - r < 0.0066$ computed.

$r' - r = 0.1675$ assumed.

As no change of mass or density within the limits of probability will account for so large differences, we must therefore still further reduce the width of the rings.

By trying different values, it will be found necessary to diminish $r' - r$ so far, that the intervals occupy nearly as much area as the reflecting surface, which cannot be admitted, for reasons before given.

We will take $r' - r = 0.02$, which corresponds to eleven equal rings distant from each other by 0.01.

For the outside ring,

$t = 0.59$ $f > 0.0023$ $\mathfrak{f} > 0.0202$

$f = -0.0036$, tendency is from the surface.

$\mathfrak{f} = 0.0144$

$r' - r < 0.0097$ computed.

$r' - r = 0.0200$ assumed.

For the middle ring,

$f > 0.0172$ $\mathfrak{f} > 0.0205$ $t = 0.46$

$f = 0.0046$ $\mathfrak{f} = 0.0075$

$r' - r < 0.0064$ computed.

$r' - r = 0.0200$ assumed.

For the inner ring,

$f > 0.0415$ $\mathfrak{f} > 0.0288$ $t = 0.34$

$f = .0113$ $\mathfrak{f} = -0.0004$

$r' - r < 0.0031$ computed.

$r' - r = 0.0200$ assumed.

(*Continued on the next page.*)

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On the Rings of Saturn, by Mr. G. P. Bond.

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ON THE RINGS OF SATURN.

By G. P. BOND,

ASSISTANT AT THE OBSERVATORY OF HARVARD UNIVERSITY.

(*Continued from page* 8.)

In order to preserve the mass as previously adopted, we must suppose an average density about three times that of *Saturn*. By recomputing f and f' for the inner ring with a density $= 3$, we obtain,

$$f = +0.0263 \qquad f' = +0.0091$$

$$r' - r < 0.0101$$

$$r' - r = 0.0200$$

A density six times that of *Saturn* would just suffice to retain the particles on the surface of the inner ring. To effect this without changing the mass, we must diminish b in the same proportion. But the attraction of a thin and narrow ring upon a particle at the extremity of its major axis varies nearly as $b \times$ density. *Mécanique Céleste*, Vol. II. [2095]. Therefore f is not increased when we increase the density by diminishing b.

If a further diminution of width is attempted, a difficulty is encountered in the width of the intervals.

In the last case, suppose the area occupied by the intervals is already double the limit previously assigned. If we lessen the space occupied by the intervals, by bringing the adjacent rings nearer together, f decreases instead of increases.

But there are still stronger objections to a large number of small rings near to each other.

It is known in the case of a single ring, that, if it were perfectly uniform in every part of its circumference, the slightest exterior disturbance would precipitate it upon the body of the planet. To avoid this catastrophe, we must suppose each ring to be an irregular solid, its center of gravity not coinciding with its center of figure, but having a motion of rotation about the body of *Saturn*. In addition to this, a number of regular concentric rings are in a position of unstable equilibrium, by virtue of their own mutual attractions. The slightest inequality in the intervals would have the effect of throwing the whole system into confusion.

Let us suppose, for instance, that the inner ring deviate by ever so small an amount from an exact central position with reference to the ring outside it. The nearest sides commence moving together, until they come in contact. All the others must follow. The consequence of such a conflict of these masses, each urged by different velocities, corresponding to the different times of rotation of the several rings, must be fatal to the whole structure.

It is therefore again necessary that the rings be not of regular figure or density.

But if these irregularities are small, there will be only a feeble resistance opposed to their tendency to fall upon the body of the planet.

On the other hand, if they be large, they will become the source of mutual disturbances, which must end in their destruction, by causing them to fall upon each other. The smallness of the intervals between them, and the near equality in the period of rotation of two adjacent rings, will make the danger of the latter event imminent, if not wholly unavoidable.

The nearness of the rings will in any case render it impossible that they can assume a figure of equilibrium permanent or nearly so.

The hypothesis that the whole ring is in a fluid state, or at least does not cohere strongly, presents fewer difficulties.

There being no longer an unyielding coherence between the particles of the inner and outer edges, they have not necessarily the same period of rotation about *Saturn*. A continual flow of the inner particles past the outer may be supposed, by which the centrifugal force will be brought into equilibrium with the other forces. And even should an accumulation of disturbances, of which the absence of inequalities lessens the probability, bring the rings together, the velocities at the point of contact will be very nearly equal, and the two will coalesce without disastrous consequences.

If in its normal condition the ring has but one division, as is commonly seen, under peculiar circumstances it might be anticipated that the preservation of their equilibrium would require a separation in some regions of either the inner or outer ring; this would explain the fact of occasional subdivisions being seen. Their being visible for but a short time, and then disappearing, to the most powerful telescopes, is accounted for by the removal of the sources of disturbance, when the parts thrown off would reunite.

Finally, a fluid ring, symmetrical in its dimensions, is not of necessity in a state of unstable equilibrium with reference either to *Saturn* or to the other rings.

THE CATENARY CURVE

TREATED BY MEANS OF PEIRCE'S CIRCULAR COÖRDINATES.

By THOMAS HILL.

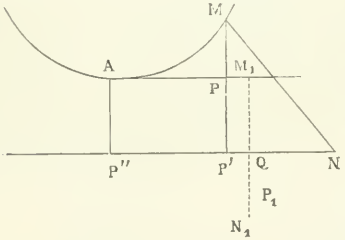
The equation of the catenary given in treatises on Mechanics may be written, $s = a\,\frac{d\,y}{d\,x}$; in which s is the length of the chain, measured from the lowest point, and a is the length of chain required to represent by its weight the horizontal tension. Differentiating the equation,

$$s = a\,\frac{d\,y}{d\,x} = a\ D_x y = a \tan \tau = a \cot \nu,$$

we get for the radius of curvature, ϱ,

$$\varrho = D_\nu\, s = D_\tau\, s = a \sec^2 \tau.$$

(1.) Since ϱ never changes sign, passes through the same values in the same order when τ is negative, and is of the same value for the four places in which $\sec \tau$ is of the same numerical value, it follows that the catenary is an *oval* of infinite diameters.



(2.) The integral $\int \varrho \sin \tau$ gives for the point M, $M\ P = -a + a \sec \tau$, $M\ P' = a \sec \tau$, $M\,N = M\ P' \sec \tau = a \sec^2 \tau = \varrho$.

That is, the radius of curvature of the catenary is found by drawing a normal to the curve until it meets a horizontal line drawn at the distance a below the vertex.

(3.) If $M\,P'$ be a thread of infinitesimal weight, and the curve $A\,M$ be flattened to the strait line $A\,M_1$, P_1 will be on an equilateral hyperbola whose center is A and semiaxis a. For if we take the coördinates of P_1,

$$y = A\,M_1 = A\,M = a \tan \tau, \quad x = M_1\,P_1 = M\,P' = a \sec \tau,$$

we have $x^2 - y^2 = a^2$, the well-known equation of an equilateral hyperbola.

(4.) If the line $P''\,N$ be removed, parallel to itself, the distance d, the resulting locus of P_1 would be the same as before, the center of the hyperbola being at the vertical distance d from A.

(5.) The converse, threads suspended from the hyperbola, will not produce the catenary, unless they are placed at infinitesimal distances, fastened to fixed points in a horizontal chain, and allowed to slide together on the hyperbola as it is flattened to a straight line, so that each thread shall remain vertical. (9.)

(6.) If the normal $M\,N$ remains attached to the chain, its extremity N_1 will be found on a parabola, whose vertex is at P'' and parameter a. For if we take the coördinates of N_1,

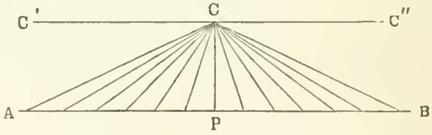
$$y = P''\,Q = A\,M_1 = A\,M = a \tan \tau,$$
$$x = Q\,N_1 = N_1\,M_1 - Q\,M_1 = M\,N - a = a \sec^2 \tau - a,$$

we have $y^2 = a\,x$, the well-known equation of the parabola.

(7.) The angle which the normal in its new position makes with the parabola being called τ', we have,

$$\tan \tau' = D_x y = \tfrac{1}{2} \cot \tau = \tfrac{1}{2} \tan M\,N\,Q.$$

(8.) In the converse, to obtain a catenary from a parabola, the abscissas $(N_1\,M_1)$ must be wires, fastened to fixed points (M_1) in the flexible straight line $(A\,M_1)$, but allowed to slide apart on the parabola when straightened.



(9.) If each link of a horizontal chain, inextensible and incontractible, be tied by a thread to a point (C) above it, and if the ends of these threads be then allowed to slide freely on a horizontal line $C'\,C''$ passing through C, the chain will assume the form of an inverted catenary.

For if the point C were below the chain, and the threads cut at C, the cut ends would fall into an equilateral hyperbola; the coördinates of the end of either, as $B\ C$, becoming

$$y = P\,B = P\,C \tan P\,C\,B, \quad x = B\,C = P\,C \sec P\,C\,B,$$

whence $x^2 - y^2 = P\,C^2$.

If the threads be cut on a horizontal line, above or below C, the ends will fall into an hyperbola of an eccentricity differing from $\sqrt{2}$.

(10.) A perpendicular let fall from the focus of a parabola upon the tangent, meets it in a straight line, tangent at the vertex.

The equation of the parabola being $y^2 = 4\,p\,x$, we have for the equation of the tangent

$$y_0\,y = 2\,p\,(x + x_0),$$

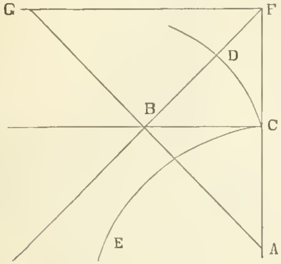
and that of the perpendicular let fall from the focus is

$$y = \frac{y_0}{2\,p}\,(p - x),$$

which give us for the point of intersection,

$$x = 0, \qquad y = \tfrac{1}{2}\, y_0.$$

(11.) A parabola may be readily described by drawing lines from the focus to a straight line tangent at the vertex, and erecting perpendiculars to each line at its extremity. These perpendiculars will by their intersection form a polygon circumscribed about the parabola, and the curve be supplied by the eye. The mechanic may simply apply one side of his square to a pin at the focus, and the corner to a straight line, and "scribe" on the other limb of the square.



(12.) If $C\,E$ be a parabola, $C\,D$ its involute, A its focus, and $C\,B$ a tangent at the vertex; if $C\,A\,B = \varphi$, $A\;B\;D = \frac{1}{2}\,\pi$, and $A\;C = a$, then we have for the catenary whose equation is

$$s = a \tan \tau,$$

referred to rectangular axes, the origin being at a point at the distance a below the lowest point of the chain,

$$B\,C = s, \quad \varphi = \tau, \quad \varrho = A\,F, \quad B\,D = x, \quad A\,B = y\,;$$

and for the evolute of the catenary referred to the same axes,

$$\varrho' = 2\,F\,G, \quad y' = 2\,A\,B, \quad x' = -\,D\,F, \quad s' = C\,F.$$

Proof for the catenary: Geometrical investigation of the differentials gives

$$d\,(B\,D) = \cos\varphi\; d\,(C\,B) = a \cos\varphi\; d \tan\varphi. = a.\, d\,\varphi.\sec\varphi,$$

while in the catenary we have

$$d\,x = d\,\tau\,\varrho \cos\tau = a\,d\,\tau \sec\tau.$$

Hence $B\;D = x$; and the other values are evident.

Proof for the evolute:

$$\begin{aligned} x - x' &= \varrho \sin\tau = a \sec^2\tau \sin\tau \\ y' - y &= \varrho \cos\tau = a \sec\tau = y \\ \varrho' &= D_\tau\, \varrho = 2\,a \sin\tau \sec^3\tau. \end{aligned}$$

$$D\;F = a \sec\varphi \tan\varphi - x = a \sec^2\varphi \sin\varphi - x$$

$$A\;B = y \qquad 2\;F\;G = 2\;a \sec^2\varphi \tan\varphi = 2\;a \sec^3\varphi \sin\varphi,$$

and it needs but the change of φ into τ.

(13.) We have for the radius of the parabola at the point x_0, y_0,

$$\varrho_1 = 2\;A\;G.$$

Proof. The distance from B to the point x_0, y_0, is by (10) equal to $B\;F = a$ sin $\sec^2$, and the differential coefficient of the arc at $x_0\, y_0$ is

$$\varrho_1 = D_\tau\, s_1 = D_\varphi\,(B\;F) + D_\varphi\,(B\;D) = a\,(\sec_\varphi + 2 \sin^2_\varphi \sec^3_\varphi + \sec_\varphi) = 2\;a \sec^3_\varphi,$$ and $D_\tau = D_\varphi$ by construction.

(14.) The involutes of a curve and its isoperimetrical polygon differ less than the curve and polygon themselves.

(15.) If every third vertex of a circumscribed polygon be joined to the center of the intervening side, the new polygon thus formed is nearer isoperimetry with the curve.

The quadrilateral thus formed in a circumscribed hexagon differs from isoperimetry with the circle about .08, the hexagon about .32.

(16.) The preceding results afford a neat geometrical mode of drawing a catenary.

Draw a parabola by the process of (11). Draw its involute by (15), using either a thread and pins inserted at each third intersection of the tangents and the centers of intervening sides, or compasses beginning with the smaller and proceeding to the larger arcs. Then set off the catenary by the rectangular coördinates, $A\;B$ and $B\;D$, of (12). A method which may give better results is, to set off the evolute of the catenary by the rectangular coördinates of (12), $2\;A\;B$ and $D\;F$, and then draw its involute. Isoperimetry with the evolute may be secured by the equation $s' = C\,F$.

(17.) The curves expressed by the equation

$$\varrho = A \sin^n \nu,$$

have several geometrical properties in common, and may have an interesting connection with each other, similar to what has now been shown to hold between

$$\varrho = a \sin^{-2} \nu, \text{ and } \varrho = A \sin^{-3} \nu.$$

(18.) The methods of the preceding discussion open a new field for geometrical integration of trigonometric functions.

FROM A LETTER OF PROFESSOR RÜMKER TO THE EDITOR.

Hamburg, 1851, *April* 15.

I TAKE the liberty of sending you the latest elements of *Egeria*, computed by my son, from the Altona observations of November 13, and the two Hamburg observations of December 31 and March 2. They represent the middle observation thus: —

	Comp. — Obs.
Longitude	—0.″10
Latitude	—0.03

January 0.0, 1851, Greenwich M. T.

M	299°	13′	1.″67	
π	118	48	7.17	M. Equinox, Jan. 0, 1851.
☊	43	17	3.51	
i	16	33	2.13	
ϕ	4	57	13.5	
Log. a	0.4114765			
" μ	2.9327918			

My latest observations of *Metis* (not corrected for parallax) are, —

1851.	Hamburg M. T.	α	δ	1851.	Hamburg M. T.	α	δ
	h. m. s.	° ′ ″	° ′ ″		h. m. s.	° ′ ″	° ′ ″
March 22	9 8 57.1	136 58 43.8	25 13 37.0	April 3	8 23 3.7	137 18 9.2	24 32 19.2
30	8 37 51.5	137 4 9.9	24 48 11.2	7	8 8 43.5	137 39 2.6	24 14 34.0
31	8 31 6.4	137 6 54.2	24 43 35.9				

LATITUDE OF MARKREE OBSERVATORY,

BY OBSERVATIONS WITH THE MERIDIAN-CIRCLE.

BY MR. A. GRAHAM.

[Communicated by E. J. COOPER, Esq.]

Quick Stars.

1850.	Colat.	Weight.
April 29	35° 49′ 29″.80	1.33
May 1	28.43	2.10
2	28.03	1.69
3	26.845	.67
4	28.34	.67
6	28.52	1.33
8	27.12	.67
15	28.325	.50
21	28.89	2.22
22	29.03	2.18
30	28.50	1.20
31	28.65	1.20
June 1	27.945	1.00
5	28.69	.50
7	27.77	1.20
15	28.725	.75
17	28.91	.67
Mean	28.493	19.88

Polaris, Lower Transit.

1850.	Colat.	Weight.
May 1	35° 49′ 28″.085	1.
2	28.28	2.
3	28.135	0.50
4	29.045	2.
6	28.145	2.22
8	27.86	1.43
21	27.49	2.
22	28.155	2.
30	27.185	4.
31	28.02	2.
June 1	28.535	2.
Mean	28.003	21.15

Polaris, Upper Transit.

1850.	Colat.	Weight.
May 5	35° 49′ 27″.34	0.50
6	28.07	2.22
29	28.74	2.
30	27.795	4.
31	28.18	1.20
June 4	28.335	2.
Feb. 8	28.685	2.
Mean	28.198	13.92

	Colat.	Weight.
Quick Stars,	35° 49′ 28″.493	19.88
Polaris, Lower Transit,	28.003	21.15
Polaris, Upper Transit,	28.198	13.92
Mean of all,	35 49 28.230	54.95

Latitude 54° 10′ 31″.77.

OBSERVATIONS OF METIS,

MADE WITH THE MERIDIAN-CIRCLE, AT THE OBSERVATORY OF EDWARD J. COOPER, ESQ., MARKREE.

BY MR. A. GRAHAM.

Greenwich M. T.	α	δ	No. Wires.	Obs. — Calc. R. A.	Obs. — Calc. Decl.
	h. m. s.	° ′ ″		s.	″
1850, Dec. 11.706193	9 58 22.72	+18 55 15.0	5	—0.03	0.0
1851, Jan. 8.640815	10 1 15.31	20 43 24.1	5	+0.06	0.0
17.613244	9 56 31.84	+21 42 41.6	1	+0.17	+2.4

Greenwich M. T.	α	δ	No. Wires.	Obs. — Calc.	
				R.A.	Decl.
	h. m. s.	° ′ ″		s.	″
1851, Jan. 21.590220	9 51 10.86	+22 32 10.6	4	+0.06	+3.1
31.566553	9 44 42.31	23 20 53.2	5	—0.28	+2.0
Feb. 7.542498	9 37 34.18	21 5 22.2	5	—0.17	+4.3
20.497877	9 24 23.53	25 6 34.0	5	—0.34	+2.1
21.491362	9 23 27.72	25 9 48.4	3	—0.06	—1.2
22.491131	9 22 32.24	25 12 55.1	5	—0.54	+0.8
26.477815	9 19 4.78	25 23 1.7	5	—0.33	+0.7
Mar. 1.467965	9 16 41.12	25 28 17.5	4	—0.12	+0.7
3.461547	9 15 18.17	25 30 43.1	5	—0.16	+1.8
6.452018	9 13 22.16	25 32 43.3	5	—0.29	+2.6
7.448885	9 12 47.39	25 32 55.1	5	—0.07	—0.2
10.439613	9 11 13.62	25 32 27.8	5	—0.16	+2.9
12.433542	9 10 20.77	25 31 6.7	5	—0.18	+1.5
18.115875	9 8 29.58	25 22 39.1	5	—0.09	+0.9
20 410167	9 8 8.09	25 18 28.1	5	—0.28	+2.0
29.385594	9 8 8.12	21 51 50.8	5	—0.25	+1.3
April 2.375025	9 8 57.00	24 36 23.9	2	—0.14	+3.2
8.360307	9 11 2.95	+21 9 22.7	5	—0.05	—2.4

Correction for parallax and compared places computed from my last set of elements, *Astr. Nachr*, No. 741, p. 381.

Jan. 8. *Metis* much brighter than was expected.
" 17. Clouds.
Feb. 21. Extremely faint. Clouds at the last three wires.
Mar. 1. Clouded at fourth wire.
" 6. Unsatisfactory.
" 7. Very faint.
" 10. Bad illumination.
April 2. Transits very uncertain ; bisection not good.

FROM A LETTER OF LIEUTENANT GILLISS TO THE EDITOR.

Santiago de Chile, 1851, *March* 23.

You are aware I have but two assistants, and that, since the injury to the micrometer screw, both are required at the zones together, one being at the telescope and the other at the microscope. In a climate like this their eyes would not last a month, if used every night, and therefore their duty every alternate night extends from 6 P. M. till 1 A. M., during which time every instrumental adjustment is twice examined, the clock-error determined, and a zone of 1½ hours long observed. On the other nights I have latterly taken up those stars in LACAILLE's Catalogue, south of this zenith, which have never been observed by any one else, and herewith send you a list of errors detected since writing to Professor HUBBARD. We have thus no force for comet-searching at present, but before the autumn (your spring) closes, I hope to have the gentlemen who were appointed by the Chilian government at work with a five-foot Equatorial which I have recently mounted and lent to them.

We have made a thorough sweep of the space within 5° of the pole from R. A. 3h. 30m. to 11h. 0m., and from 16h. to 23h., going over it five different nights; so as to secure at least two independent observations of every star to the 10 magnitude inclusive. The total number of stars found is 290, — of which there is one of the 9 magnitude which performs its revolution in the field of the meridian-circle telescope.

March 24. At 0h. 21m. this morning, we had quite a severe earthquake. It was preceded by a louder noise than usual for some four or five seconds, the noise ceasing at the instant that the shock was under foot. The motion was distinctly undulatory, the wave coming from the north. Of course the adjustments of our instruments are all disturbed, but I do not learn that any other harm has been done than the fright.

ERRORS IN THE CATALOGUES OF THE BRITISH ASSOCIATION AND LACAILLE.

British Association Catalogue.

No. 2065. Does not exist. The nearest star to it so bright as 6.7 is No. 2249 LACAILLE.
" 3328. Does not exist. It is B. A. C. 3323.

Lacaille's Catalogue.

No. 2165. P. D. more than 1′ too great.
" 2207. R. A. 30s. too little.
" 2352. No such star. It is no doubt 2344, whose P. D. should be 135° 8′.
" 2354. P. D. more than 1′ too little.
" 2378. P. D. should be 137° 17′.
" 2491. P. D. should be 135° 10′.
" 2499. R. A. should be 6h. 43m. 7s. and P. D. 127° 56′.
" 2679. No star so large as 9½ magnitude at this P. D. within 2m. R. A.

No. 2759. No such star within 2½$^{m.}$ R. A. and 1′ P. D.
" 2770. P. D. wrong —2′ 20″.
" 2824. P. D. wrong —1′.
" 2791. R. A. wrong —20$^{s.}$.
" 3071. P. D. wrong —3′.
" 3126. Our observation agrees with Brisbane 1855.
" 3198. There is a star at R. A. 8$^{h.}$ 2$^{m.}$ 53$^{s.}$, and P. D. 141° 51′, but none here.
" 3335. R. A. 1$^{m.}$ 20$^{s.}$ too little.
No. 3347. No star in this place.
" 3409. The nearest star to this is R. A. 8$^{h.}$ 24$^{m.}$ 46$^{s.}$, P. D. 134° 55′ 8″.
" 3425. R. A. should be 8$^{h.}$ 25$^{m.}$.
" 3426. P. D. should be 127° 36′.
" 3633. Not found March 16, 1851.
" 8020. Brisbane's P. D. is correct.

The corrections refer to the epoch of Lacaille's Catalogue.

J. M. GILLISS.

ELEMENTS AND EPHEMERIS OF IRIS, FOR 1853.

By E. SCHUBERT.

[Communicated by Lieutenant Davis, Superintendent of the Nautical Almanac.]

Perturbations from 1848, January 1.0 to 1853, March 23.0.

	δ i	δ ☊	δ φ	δ π	δ μ	∫ δ μ	δ M
♃	−1″.87	−314″.88	+245″.52	−709″.48	+0″.47175	+276″.45	+625″.89
♄	+0.69	− 11.99	+ 2.58	+ 16.95	+0.00763	+ 16.67	− 23.08
♃ + ♄	−1.18	−5′ 26.87	+4′ 8.10	−11′ 32.53	+0.47938	+4′ 53.12	+10′ 2.81

Osculating Elements.

1853, March 23.0, M. T. Washington.

M	121° 36′ 28″.58	
π	41 18 59.86	M. Equinox, March 23.0.
☊	259 44 48.67	
i	5 28 15.95	
φ	13 25 52.70	
μ	963″.34338	
Log. a	0.3774836	

Ephemeris for the Opposition.

12$^{h.}$ M. T. Washington.	🌈 α	🌈 δ	Log. r	Log. △
	h. m. s.	° ′ ″		
March 1	12 12 42.63	−10 20 32.4	0.433710	0.253266
2	11 51.09	16 39.8	.434002	.252246
3	11 4.61	12 36.3	.434292	.251286
4	10 14.22	8 21.9	.434581	.250387
5	9 22.99	10 3 56.9	.434869	.249550
6	8 30.98	9 59 21.5	.435155	.248777
7	7 38.26	54 36.0	.435441	.248068
8	6 41.87	49 40.7	.435725	.247426
9	5 50.88	44 35.8	.436007	.246851
10	4 56.35	39 21.7	.436289	.246343
11	4 1.36	33 58.8	.436569	.245903
12	3 5.95	28 27.2	.436848	.245533
13	2 10.19	22 47.5	.437125	.245233
14	1 14.14	17 0.0	.437401	.245004
15	12 0 17.88	11 5.1	.437676	.244817
16	11 59 21.47	−9 5 3.1	0.437950	0.244757

12ʰ· M. T. Washington.	⌓ α	⌓ δ	Log. r	Log. △
	h. m. s.	° ′ ″		
March 17	11 58 24.96	—8 58 54.5	0.438223	0.244740
18	57 28.45	52 39.8	.438494	.244795
19	56 31.96	46 19.2	.438764	.244921
20	55 35.58	39 53.4	.439032	.245119
21	54 39.36	33 22.7	.439300	.245388
22	53 43.37	26 47.5	.439566	.245728
☍ 23	52 47.66	20 8.2	.439830	.246139
24	51 52.28	13 25.3	.440094	.246620
25	50 57.31	8 6 39.2	.440356	.247172
26	50 2.81	7 59 50.4	.440617	.247794
27	49 8.79	52 59.3	.440877	.248484
28	48 15.34	46 6.4	.441135	.249244
29	47 22.52	39 12.0	.441393	.250071
30	46 30.38	32 16.7	.441649	.250966
31	45 38.97	25 20.9	.441903	.251928
April 1	44 48.34	18 24.9	.442157	.252955
2	43 58.52	11 29.4	.442409	.254047
3	43 9.60	7 4 34.7	.442660	.255204
4	42 21.61	6 57 41.3	.442909	.256422
5	41 34.58	50 49.6	.443157	.257703
6	40 48.57	44 0.1	.443404	.259044
7	40 3.62	37 13.1	.443650	.260445
8	39 19.79	30 29.1	.443895	.261904
9	38 37.10	23 48.5	.444138	.263419
10	37 55.59	17 11.7	.444380	.264990
11	37 15.30	10 39.0	.444621	.266614
12	36 36.26	6 4 10.9	.444860	.268291
13	35 58.51	5 57 47.7	.445098	.270018
14	11 35 22.07	—5 51 29.8	0.445335	0.271793

The observations are to be corrected for aberration and parallax before comparison with the ephemeris.

Opposition.

1853, March 22, 1ʰ· 13ᵐ· 56ˢ·.0, M. T. Washington.

Mean Longitude,		182° 4′ 8″.2
Geocentric Latitude,	—	8 22 17.8
Heliocentric Latitude,	—	5 20 44.8
Intensity of Light,		0.465

Approximate Ephemeris.

(Calculated directly from 10 to 10 days with the opposition, elements without any alteration.)

0ʰ· M. T. Wash'n	⌓ α	⌓ δ	Log. r	Log. △	0ʰ· M. T. Wash'n.	⌓ α	⌓ δ	Log. r	Log. △
	h. m.	° ′				h. m.	° ′		
Jan. 0	12 18.2	—8 30.8	0.4137	0.3722	May 30	11 32.4	—3 24.3	0.4548	0.3805
10	23.4	9 29.9	.4173	.3498	June 9	37.5	3 31.8	.4565	.4057
20	26.4	10 15.0	.4208	.3275	19	44.3	3 51.8	.4581	.4300
30	26.8	10 44.8	.4242	.3056	29	11 52.3	4 22.7	.4596	.4529
Feb. 9	24.8	10 56.8	.4275	.2850	July 9	12 1.6	5 3.1	.4610	.4742
19	20.1	10 49.6	.4306	.2673	19	11.8	5 51.5	.4623	.4939
March 1	13.1	10 22.4	.4336	.2538	29	22.8	6 46.6	.4634	.5118
11	12 4.5	9 36.9	.4364	.2461	Aug. 8	34.5	7 47.0	.4644	.5280
21	11 55.1	8 36.6	.4392	.2453	18	46.8	8 52.0	.4653	.5423
31	46.1	7 28.8	.4418	.2514	28	12 59.6	10 0.1	.4661	.5550
April 10	38.3	6 20.6	.4443	.2642	Sept. 7	13 13.0	11 10.7	.4667	.5658
20	32.4	5 18.6	.4466	.2824	17	26.7	12 22.7	.4672	.5749
30	28.9	4 28.2	.4488	.3044	27	40.9	13 34.9	.4676	.5823
May 10	27.8	3 51.4	.4510	.3289	Oct. 7	13 55.4	14 46.9	.4679	.5879
20	11 29.0	—3 30.6	0.4529	0.3546	17	14 10.2	—15 57.6	0.4681	0.5917

$0^{h.}$ M. T Wash'n	⌓ α	⌓ δ	Log. r	Log. Δ	$0^{h.}$ M. T Wash'n	⌓ α	⌓ δ	Log. r	Log. Δ
	h. m	° ′				h. m	° ′		
Oct. 27	14 25.3	—17 6.2	0.4682	0.5938	Dec. 6	15 27.4	—21 6.0	0.4673	0.5843
Nov. 6	40.6	18 12.1	.4681	.5942	16	43.0	21 51.0	.4667	.5773
16	14 56.1	19 14.3	.4680	.5927	26	15 58.6	22 36.5	.4661	.5685
26	15 11.7	—20 12.5	0.4677	0.5894	36	16 14.0	—23 12.9	0.4653	0.5578

NEW WORKS.

1. The valuable Treatise on Practical Astronomy by Professor Sawitch of St. Petersburg, originally published in the Russian language in 1845, and honored with a prize by the Imperial Academy, has been translated into the German language by Dr. Goetze of Hamburg, and published in two volumes, under the title *Abriss der practischen Astronomie, vorzüglich in ihrer Anwendung auf geographische Orts-Bestimmung.* Hamburg, 1851. The need of such a work has long been keenly felt. The treatise of Bohnenberger referred chiefly to the sextant; and this, as well as the "Practical Astronomy" of Dr. Pearson, — though each unquestionably a work of great value at the time of publication, — has been left behind by the subsequent progress of science.

The treatise of Professor Sawitch is intended to supply the present need of a work of this kind, and to furnish a compend of the labors of Encke, Gauss, Bessel, and Struve, in the department of practical astronomy. The author especially acknowledges his indebtedness to Professor Struve, having had the privilege of profiting by the instructions of the great master at the Dorpat University, and of living in the immediate vicinity of the Observatory at Pulkowa.

Dr. Goetze has added to his important services to astronomy by rendering Professor Sawitch's book accessible to those astronomers who are unacquainted with the Russian language, and has illustrated the Gaussian method of computing eclipses, a description of which the author had communicated for insertion in the translation, by a full calculation of the total eclipse of 1851.

Would not a translation of this book into English be of essential service? It might advantageously be accompanied by a digest of the writings of Struve and Bessel on the larger fixed astronomical instruments, and Kaiser's treatise on Micrometers.

In a private letter to the Editor, Dr. Goetze states that he is about commencing a translation of the great Russian work of General Bolotoff, "On Geodetical Operations and Trigonometrical Surveys."

2. *Berechnung der Bahn des Neptunstrabanten*, von August Struve. Professor Mädler of Dorpat has published the computation of the orbit of the satellite of *Neptune*, completed in 1849 by August Struve, nephew of the Director of the Pulkowa Observatory.

The author devoted himself to mathematics and astronomy, and had just left the University to pursue his astronomical studies with his uncle at Pulkowa, when he died of consumption, in the winter of 1850, at the early age of twenty-three.

Professor Mädler published the calculation in a quarto pamphlet of twenty-six pages in memory of the ability and promise of the deceased, and for the honor of the University of Dorpat.

G.

CORRIGENDA.

Vol. I., page 191, col. 2, line 24, *for* $4^{h.}\ 44^{m.}\ 39^{s.}.5$, *read* $4^{h.}\ 44^{m.}\ 29^{s.}.5$.
" II., " 2, Nov. 18, in column α, *for* $32^{m.}\ 21^{s.}.16$, *read* $32^{m.}\ 22^{s.}.16$.
" 2, Dec. 11, " Δα, " $-3^{m.}\ 17^{s.}.15$, " $+3^{m.}\ 17^{s.}.15$.
" 3, Feb. 18, " α, " $34^{m.}\ 18^{s.}.17$, " $34^{m.}\ 58^{s.}.17$.
" 3, March 2, " Δδ, " $-5'\ 36''.10$, " $-5'\ 37''.10$.
" 3, " 13, " Δδ, " $+15'\ 42''.51$, " $+15'\ 42''.11$.

In the orbit of *Egeria* by Professor Hubbard, as printed on p. 4, the symbols ω and ☊ are interchanged.

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CAMBRIDGE: METCALF AND COMPANY, PRINTERS TO THE UNIVERSITY.

THE

ASTRONOMICAL JOURNAL.

No. 27.

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ON THE CONSTITUTION OF SATURN'S RING.

By BENJAMIN PEIRCE, LL. D.,

PERKINS PROFESSOR OF ASTRONOMY AND MATHEMATICS IN HARVARD UNIVERSITY.

The following abstract of the memoir which I read before the American Association for the Advancement of Science, at the meeting in Cincinnati, is intended to be sufficiently complete to enable geometers to comprehend and verify the principal features of my analysis; and, thereby, to authorize me to postpone the publication of the memoir until I have relieved myself from the immediate pressure of other engagements. The substance of this memoir was originally communicated to the American Academy, on the 15th of April, in the form of remarks upon Mr. Bond's memoir, which was read at that meeting, and has been published at length in this Journal.

1. Mr. Bond's argument for the fluidity of *Saturn's* ring is chiefly derived from observation; whereas I have undertaken to demonstrate, from purely mechanical considerations, that it cannot be solid. I maintain, unconditionally, that *there is no conceivable form of irregularity and no combination of irregularities, consistent with an actual ring, which would serve to retain it permanently about the primary, if it were solid.* Laplace's statement of the sustaining power of an irregularity, in which he has been blindly followed by his successors, was evidently a careless suggestion, which was dropped at random, and never subjected to the scrutiny of a rigid analysis.

In my researches, I have had regard, not only to the motion of translation of the ring, but also to its rotation upon its axis; and it is this latter phenomenon which deprives the irregularity of its sustaining power. For, by means of the rotation, the irregularity will be brought to that position in the ring which is nearest to the primary, as often as to that which is most remote. However much, in this latter position, it may diminish or even negative the repulsive action, investigated by Laplace, between the primary and center of gravity of the symmetrical ring, it will still more increase this repulsion in the other position; and it will be found that, on this account, the irregularity even tends to accelerate the fall and destruction of the ring.

The only supposable case, in which the injurious action of the irregularity can be avoided, is that in which the time of the ring's rotation upon its axis is the same with that of the revolution of the center of gravity about the primary, and in which the irregularity is at that point of the ring which is farthest from the primary. This hypothesis might seem to be sustained by the analogy of the moon and the other satellites. But analysis shows that there is a difference between the cases, which is of fundamental importance. The position of the moon, with its longest axis directed to the earth, is known to be a stable position, whereas the supposed case of the ring is conclusively unstable. This is plain enough, when the center of gravity of the ring and its center of figure are both upon the same side of the planet. For, in this case, we may for an instant separate the irregularity from the ring, regard the rest of the ring, supposed to be symmetrical, as collected into one mass at its center of figure, and unite it by an inflexible rod with the center of gravity of the irregularity. At the end of this rod, which is most remote from the planet, we shall have the irregularity attracted by the planet, while the mass of the ring, which is at the other end, is actually repelled by the primary; and this is obviously an unstable equilibrium. It is the case of the man who attempts to stand erect in water with bladders tied to his feet. When the primary is between the centers of gravity and of figure, the position may be shown to be none the less unstable by quite a simple computation.

The consideration of many irregularities is simplified by observing, that, if they are near each other, they may be regarded as combined at their center of gravity; and if they are upon opposite portions of the ring, they tend to negative each other's action. In any case, the result is essentially the same, — that they will not permanently support the ring, that a solid ring would soon be destroyed, and that *Saturn's* ring must, therefore, be fluid. It consists, in short, of a stream, or rather of streams, of a fluid somewhat denser than water, flowing around the planet.

2. Mr. Bond's bold and ingenious theory for reconciling the discrepancies of observation by a variable constitution of the ring, consisting in the frequent formation of divisions and their subsequent annihilation, seems to be clearly sustained by his own simple and novel computations. But a more recondite application of the principles of fluid action will be found to

illustrate the phenomenon, and lead to more definite views of the mode of action. The extraordinary thinness of the ring tends to facilitate the investigation. I have supposed the fluid to be of uniform density, which hypothesis seems to be almost a necessary consequence of the thinness, for it is hard to conceive that an elastic fluid like a gas would sustain itself in so compressed a state with such small dimensions.

If a small prismatic canal is drawn anywhere, from the upper to the under surface of the ring, parallel to the axis of rotation, the pressure of the contained fluid upon its middle point may be computed from the adoption of the data of the mass given by BESSEL, and of the width and diameters observed by STRUVE. The length of the canal drawn on a radius from the center of figure, which will give the same pressure at the same interior point, after making allowance for the centrifugal motion, may then be computed, and hence the proper width of each separate ring. This width will be found to be nearly independent of that most uncertain element, the thickness; so that it is possible to determine approximately the number of rings which there should be, altogether, in the normal condition; and my first approximation has given me *twenty* for this number, which I consider to be the maximum limit. The definite width of the elementary rings is, to a certain extent, analogous to the definite size of the drops of water from a vial; and as those drops may be observed to break off from the fluid above with quite an abrupt line of separation, so will the dividing of the rings of *Saturn*, as the fluid approaches that state of rest which is necessary for the phenomenon, occur with a swift and abrupt sinking in at the proper distances.

3. When I undertook to inquire into the conditions of stability of the fluid ring, I was surprised to find that, even in this case, the motion of the center of gravity was not controlled by the primary. The attraction of the planet restrains the individual particles from flying apart, and keeps them in the form of a ring; but it has no influence upon their motion as one body. So that there is nothing in the direct action of *Saturn* to prevent his ring from moving forward in its plane, in any direction and to any distance, until at last the ring would be brought into collision with the surface of the planet, and so be destroyed.

Whatever may be the figure of the ring, the velocity of its current must be slower at the points which are more remote from the planet. There must, therefore, be an accumulation of fluid at these points, and an accurate calculation shows that the amount of accumulation exactly compensates the greater distance, so that the attraction of the ring upon the primary must be the same in every direction. In making this computation, it must be observed that the accumulation of fluid is reciprocally proportional to the velocity, and that the velocity must be such as to satisfy the principle of the preservation of areas, and, otherwise, the figure of the ring may be neglected.

4. The power which sustains the center of gravity of *Saturn's* ring is not then to be sought in the planet itself, but in his satellites. The satellites are constantly disturbing the ring; and yet they sustain it in the very act of perturbation. The possibility of such an action did not escape the sagacity of the younger HERSCHEL, who has alluded to it in his *Outlines of Astronomy*. But in comparing it to the uncertain balancing of a long pole, he has failed to do it justice; while, on the other hand, he has attributed too much power to it when he has supposed it capable of sustaining a solid ring against the destructive agency of the planet. It is not a negative action, although it is feeble; and its positive power may be variously illustrated.

In the first place, each particle of the ring may be regarded as a satellite, which the other satellites disturb in the usual way. Thus the mean distance from *Saturn* is not varied in the least, and the disturbance of the eccentricity can only reach certain definite limits, after attaining which it must diminish. Relatively to an increasing or decreasing eccentricity, the different particles are in different conditions, which is reduced to an average state by their mutual pressure, and this average has its own periods of increase and diminution.

Secondly, in consequence of the attraction of its satellites, *Saturn* describes an orbit about the common center of gravity of the system. Any particle of matter, which was placed at the center of *Saturn* with the proper initial velocity, would tend to describe the same orbit. But the center of gravity of the ring is coincident in position with that of *Saturn*, so that it also must tend to describe the same orbit; that is, the action of the satellites tends to maintain the coincidence between these two centers of gravity. Allowance must, however, be made for the fact, that the satellite does not attract the ring precisely as if all its mass were collected at its center. But the deviation arising from this cause may be neglected in the mean motion, and referred to the class of periodical perturbations. It should also be observed, that the inequality of action from this source is diminished by the increased velocity in the current of the ring upon the portion which is nearest to the satellite, and the consequent accumulation of fluid in the more remote portions.

5. It follows, then, that no planet can have a ring, unless it is surrounded by a sufficient number of properly arranged satellites. *Saturn* seems to be the only planet which is in this category; and it is the only one, therefore, which could sustain a ring. Our sun, also, does not appear to have its satellites properly disposed for supporting a ring; and the only part of the system where such a phenomenon might have been reasonably expected is just within the powerful masses of *Jupiter* and *Saturn*. But had there been a ring at this part of the system, it must have been subject to such extraordinary perturbations that it would in the course of time have been vibrated up against the next inferior planet, *Mars;* and in this way have been broken into the asteroids. The orbits of planets, formed under such circumstances, must have been characterized by great eccentricity.

6. But suppose that, from any cause whatever, the sun had, at some period, been surrounded by a light ring comparable in levity to the zodiacal light; and, in order to escape the planetary influences, we may suppose the plane of the ring to have

had a large inclination to the ecliptic. The result would have been, that the center of gravity of the ring would have soon begun to move in some direction or other, and continued moving until it was brought against the surface of the sun. But during this motion, and in consequence of the solar action, the matter of the ring would have accumulated at the most remote part; so that, if the sun had been a mere point, it would have happened that, precisely at the instant of its expected collision with the ring, the whole ring would have escaped from the point of contact. The experiment of Tantalus would have been performed upon a grand scale, and the ring would have been instantaneously transformed into a comet in its aphelion.

7. Were the ring, however, supposed to be a large gaseous mass of a circular figure, the condensation which would occur at the point of aphelion might easily lead to chemical action. Precipitation might ensue, and the necessary consequence would seem to be a continually accelerated accumulation at this point, which would terminate in the formation of a planet. Under this modification, the nebular hypothesis may possibly be free from some of the objections with which it has been justly assailed. But in approaching the forbidden limits of human knowledge, it is becoming to tread with caution and circumspection. Man's speculations should be subdued from all rashness and extravagance in the immediate presence of the Creator. And a wise philosophy will beware lest it strengthen the arms of atheism, by venturing too boldly into so remote and obscure a field of speculation as that of the mode of creation which was adopted by the Divine Geometer.

OBSERVATIONS OF EGERIA.

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By Mr. JAMES FERGUSON.

Communicated by Lieutenant Maury, Director of the Observatory.

[Corrected for refraction.]

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	Egeria — Star		Egeria's apparent .		A.
				Δ α	Δ δ	α	δ	
	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″	
1850, Dec. 24	7 6 11.9	5	*a*	+0 14.83	— 0′ 9″.11	1 33 27.36	+11° 20′ 13″.68	8
	7 56 26.5	7	Weisse I. 501	+4 15.89	— 2 5.46	33 28.29	11 20 28.12	8
		7	*a*	+0 15.49	+ 0 5.32	33 28.02	11 20 28.02	8
26	6 56 32.8	10	Weisse I. 501	+4 40.68	+10 40.35	33 52.96	11 33 13.78	10
		10	" 539	+2 36.95	— 7 28.93	33 52.70	11 33 12.32	10
27	6 16 19.4	8	" 539	+2 51.72	— 1 2.07	34 7.46	11 39 39.15	6
1851, Jan. 1	6 42 2.4	16	" 646	+0 30.04	+ 2 20.99	35 47.64	12 14 28.04	7
7	6 36 42.2	11	" 732	—2 0.37	—20 28.38	38 37.29	12 58 39.17	10
11	6 24 22.4	7	" 732	+0 21.57	+10 21.52	40 59.16	13 29 28.83	10
12	6 10 50.7	13	" 732	+0 59.91	+18 9.37	41 37.50	13 37 16.62	9
	6 16 10.4	10	*b*	—0 27.38	+ 1 0.37	41 37.51	13 37 19.44	9
13	6 24 13.8	15	"	+0 13.08	+ 9 0.74	42 17.94	13 45 19.84	10
14	6 31 33.3	8	"	+0 54.97	+17 2.41	42 59.82	13 53 21.45	7
	6 41 41.0	5	Weisse I. 775	—0 14.29	— 7 18.68	42 59.83	13 53 25.66	7
16	6 14 46.2	8	" 775	+1 11.92	+ 8 36.68	44 26.03	14 9 21.31	4
	6 15 27.8	6	" 807	—0 35.32	+ 1 0.52	44 26.85	14 9 25.19	4
24	7 38 34.4	12	" 896	+0 32.37	+ 4 54.59	51 6.06	15 16 55.79	7
(1) 25	7 36 57.6	1	*d*	0 0.0	0 0.0	52 0.51	15 25 27.31	6
	7 34 7.1	5	Weisse I. 896	+1 27.32	+13 24.51	52 0.99	15 25 25.61	6
31	7 3 21.9	7	B. Z. 394	—0 31.97	— 4 6.72	1 57 54.75	16 18 1.01	8
Feb. 6	9 43 46.2	9	" 394	—2 42.44	— 0 47.33	2 4 29.64	17 12 22.71	9
7	8 43 56.9	7	" 394	—1 37.14	+ 7 46.16	5 34.92	17 20 56.18	6
11	8 8 28.4	5	Lal. 4238	—0 45.65	+11 42.32	10 15.42	17 57 19.97	6
12	8 13 58.1	10	" 4238	+1 58.52	+20 51.18	11 28.27	18 6 28.77	10
16	8 16 40.5	9	B. Z. 332	—0 50.04	— 9 19.49	16 30.35	18 43 25.17	10
17	8 11 44.9	3	" 332	+0 26.73	— 0 8.83	17 47.12	18 52 35.79	9
	9 17 5.7	10	" 332	+0 30.16	+ 0 17.70	17 50.54	18 53 2.32	9
22	8 17 6.1	16	B. Z. 391; Rümker 654	—0 39.99	— 7 53.08	24 26.20	19 38 45.00	10
26	7 41 13.7	13	B. Z. 391	+1 38.19	+12 39.14	2 29 56.96	+20 15 27.97	8

(1) Contact with star observed.

Date.	M T. Washington.	No. of Comp.	Comparison-Star.	Egeria — Star		Egeria's apparent		A.
				Δ α	Δ δ	α	δ	
	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″	
1851, March 1	8 30 19.4	11	B. Z. 391	—0 55.06	+13 7.19	2 34 18.55	+20 43 41.09	10
2	8 23 11.6	12	B. Z. 391 ; Rümker 695	—0 33.72	— 5 50.08	35 45.70	20 52 56.71	10
3	8 11 41.6	7	"	+0 53.53	+ 3 19.92	37 12.93	21 2 6.65	8
	9 18 47.1	5	"	+0 57.50	+ 3 46.04	37 16.90	21 2 32.78	8
4	9 24 56.1	2	"	+2 26.92	+12 57.70	38 46.21	21 11 44.38	7
10	8 2 0.1	7	Rümker 742	+0 54.78	—13 1.19	47 49.51	22 6 23.88	9
11	8 33 49.6	7	"	+2 30.91	— 3 37.69	49 25.63	22 15 47.29	8
13	8 1 29.7	10	B. Z. 27	—2 16.24	+ 5 27.99	2 52 33.38	22 33 43.49	10
21	8 49 5.7	3	" 530	—1 40.73	— 2 40.81	3 5 42.11	23 45 49.48	8
25	8 5 21.9	11	Rümker 845	—0 57.82	— 8 4.45	12 24.73	24 20 44.53	10
26	7 34 7.8	10	"	+0 42.81	+16 35.49	14 5.35	24 29 15.51	10
		10	Rümker 849; G. 12 Y. C., 285	—1 24.14	+17 46.12	14 5.67	24 29 13.05	10
28	9 34 39.4	11	B. Z. 530	+1 23.35	— 7 53.20	17 34.31	24 46 26.97	10
April 6	7 19 5.6	15	" 396	+0 11.92	— 3 24.71	33 41.78	26 1 58.59	10
9	8 9 52.0	10	" 396	—0 3.36	+18 59.45	39 15.28	26 26 8.32	9
11	7 45 44.9	10	" 396	+1 13.12	+ 4 58.99	42 58.50	26 42 4.66	8
	8 11 40.6	4	" 396	+1 14.92	+ 5 5.93	43 0.30	26 42 11.61	8
18	7 56 57.9	12	" 396	—0 0.82	+ 7 44.85	3 56 18.23	27 36 51.74	10
22	8 3 17.5	16	B. Z. 397 ; Rümker 1104	+0 59.13	+ 2 25.91	4 4 6.48	28 5 4.70	10
23	8 16 46.6	2	"	+2 58.57	+ 9 36.76	6 5.91	28 12 5.35	9
29	8 12 54.1	7	B. Z. 397	+1 48.58	—17 18.06	18 5.72	28 53 20.60	8
May 1	8 0 39.4	1	" 397	+5 49.22		22 6.67		7
2	8 14 57.4	2	*e*	+2 22.74	+14 30.92	4 24 11.43	+29 12 43.09	7

Several of these observations have been already published in the *Astronomical Journal*.

Adopted Mean Places, 1850.0, *of Comparison-Stars.*

*	Mag.	α	δ	Authority.	No. of Comp.
		h. m s.	° ′ ″		
Weisse I. 501	6.7	1 29 9.53	+11 22 19.45	Weisse's Catalogue.	
a	9.10	1 33 9.98	11 20 8.92	Washington Equatorial, from Weisse I. 501.	7
Weisse I. 539	8.9	1 31 12.98	11 40 27.18	Weisse's Catalogue.	
" 646	8.9	1 35 14.86	12 11 53.41	"	
" 732	9	1 40 34.94	13 18 54.50	"	
b	9.10	1 42 2.23	13 36 6.04	Washington Equatorial, from Weisse I. 732.	10
Weisse I. 775	9	1 43 11.48	14 0 31.26	Weisse's Catalogue.	
" 807	9	1 44 59.53	14 8 11.75	"	
" 896	8.9	1 50 31.10	15 11 48.72	"	
d	11.12	1 51 57.93	15 25 14.97	Washington Equatorial, from Weisse I. 896.	7
B. Z. 394	8.9	1 58 24.17	16 21 55.73	Bessel's Zones.	
B. Z. 394 ; Rümker 568	9	2 7 9.54	17 12 58.65	Bessel's Zones and Rümker (mean).	
Lal. 4238	7.8	2 9 27.28	17 45 26.47	Lalande's Catalogue.	
B. Z. 332 ; Lal. 4460	8.9	2 17 17.92	18 52 33.86	Bessel's Zones.	
B. Z. 399 ; Rümker 651	8.9	2 25 3.74	19 46 27.40	Bessel's Zones and Rümker (mean).	
B. Z. 391	9	2 28 16.36	20 2 38.92	Bessel's Zones.	
" 391	8	2 35 11.19	20 30 24.40	"	
B. Z. 391 ; Rümker 695	8	2 36 17.00	20 58 37.27	Bessel's Zones and Rümker (mean).	
Rümker 742	9	2 46 52.34	22 19 16.25	Rümker's Catalogue.	
B. Z. 27	7	2 54 47.24	22 28 7.23	Bessel's Zones.	
" 530	9	3 7 20.48	23 48 22.83	"	
Rümker 845	9	3 13 20.18	24 12 33.07	Rümker's Catalogue.	
Rümker 849 ; B. Z. 530 ; G. 12 Y. C.	6	3 15 27.45	24 11 20.08	Greenwich 12 Year Catalogue.	
B. Z. 530	9	3 16 8.62	24 54 13.32	Bessel's Zones.	
" 396	8.9	3 33 27.49	26 5 17.60	"	
" 396	9	3 39 16.36	26 7 13.59	"	
" 396	9	3 41 43.00	26 37 1.07	"	
" 397	9	3 56 16.65	27 28 2.74	"	
B. Z. 397 ; Rümker 1104	9	4 3 4.96	28 2 31.13	Rümker's Catalogue.	
B. Z. 397	9	4 16 15.00	29 10 35.89	Bessel's Zones.	
e	10	4 21 46.23	+28 58 9.81	Washington Equatorial, from preceding star.	2

The planet was searched for till the 11th of May, at which time it was so far in the twilight as to leave no hope of seeing it again.

FROM A LETTER OF PROFESSOR CURLEY TO THE EDITOR.

Georgetown College, D. C., 1851, *May* 13.

I send you a short description of a small astronomical instrument which I call a "Reflecting Sector," and use for taking the diameters of the sun and moon. In using our meridian-circle, I found it very difficult and troublesome to attend to the transits of the two limbs of the sun at the seven wires, and at the same time make the observations of the upper and lower limbs for declination. On this account, I requested Mr. Simms of London to make the instrument, which I use in the same manner as a sextant is used for finding the diameter of the sun. When I make a meridian observation of the sun, I also take the sun's diameter with the sector, so that the two observations secure the position of the sun's center. Time and experience must decide whether it will give results of the required accuracy.

The principal limb of the instrument is a flat brass bar, about 25 inches long, 2½ wide, and ¼ of an inch thick, terminating at one end in an arc 7 inches long and 1½ wide. In the face of this arc is set a narrow silver one, 10 degrees long, to a radius of 22 inches. The silver arc is graduated to single minutes, and there are 5° on each side of the zero of the arc; but the principle of reflection of course requires the divisions to be numbered from 0° to 10° on each side of the zero; hence 30 small divisions represent a degree; the index reads to 2 minutes, and the vernier to 2 seconds of arc.

The index-bar that carries the vernier has a range of 5½° on each side of the zero. The telescope is fastened (like that of a sextant) to an extension in breadth of the principal limb, which widens to 10 inches to support both the telescope and horizon-glass. The telescope has an object-glass of 1 inch in diameter and 9 inches focal length, and two eye-pieces, giving powers from 12 to 25. There are three sun-glasses, which are used at the eye-pieces *only.* No stand came with the instrument, but it is now mounted on that of our reflecting-circle.

An observation with the *reflecting-sector* is made by placing the plane of the instrument so as to pass through the vertical or horizontal diameter to be observed; then making the contact of the image seen through the horizon-glass with that reflected from the index-glass, and reading the vernier. The same is done with the index on the other side of the zero of the arc, and half the sum of the measures will be the diameter free from index error. To the vertical diameter thus found, the difference of refraction of the lower and the upper limb must be applied as a positive correction (with a plus sign), as the lower limb of the sun or moon is elevated more by refraction than the upper limb.

The contacts and readings may be repeated, as the observer chooses.

I give three observations on the horizontal diameter of the sun: —

1851,	Sun's Hor. Diam.	
April 29, noon.	31′ 23″	on *left* side of zero by two contacts.
	31 22	
	32 22	on *right*, by contacts made by advancing and removing the centers of the images.
	32 22	
	8)127 29	
	15 56.12	Semidiameter.
2d Trial.	32 10	R.
	32 10	
	31 22	L.
	31 23	
	8)127 05	
	15 53.12	Semidiameter.
	15 54.63	Mean.
	15 53.5	Nautical Almanac.
	15 54.4	Do., with Mr. Airy's correction.
	Sun's Hor. Diam.	
May 6, 1st Trial.	32′ 06″	R.
	32 04	
	31 23	L.
	31 21	
	15 51.6	Semidiameter.
2d Trial.	31 22	L.
	31 17	
	32 10	R.
	32 13	
	15 52.7	Semidiameter.
Mean	15 52.15,	and Naut. Alm. = 15′ 51″.9.
	Sun's Hor. Diam.	
May 8, noon.	32′ 04″	R.
	32 00	
	31 27	L.
	31 23	
	15 51.75	Semidiameter.
	15 51.5	Do. by Nautical Almanac.
	15 52.42	Do. with Mr. Airy's correction.

The use of the instrument so far shows that the power of the telescope is not sufficient, and should be at least 40.

JAMES CURLEY.

NEW PLANET.

Mr. Hind's unwearying zeal in the search for new members of our solar system has led him to the discovery of a fourth small planet. He announces the discovery in a letter to the London Times, communicating the following observations: —

1851.	M. T. Greenwich.	α	δ
	h. m. s.	h. m. s.	° ′ ″
May 19	12 52 36	16 4 10.41	—13 23 31.9
	13 26 36	16 4 8.81	—13 23 37.6

Cambridge, June 5.

In a subsequent number of the "Times" it is stated that **Sir John Herschel**, who was requested by Mr. **Hind** to give a name to the planet, has proposed the name *Irene* (Εἰρήνη) in allusion to the peaceful sentiments which should be fostered by the great industrial exhibition now holding in London, where the planet was discovered.

Irene resembles a star of the 9 magnitude.

G.

OCCULTATIONS OF STARS OBSERVED AT YALE COLLEGE OBSERVATORY, NEW HAVEN.

By Mr. FRANCIS BRADLEY.

Date.	M. T. New Haven.	Name of Star.	Remarks.
	h. m. s.		
1848, Feb. 14	11 41 25.4	Im. 26 Geminorum	Doubtful $1^{s.}$ or $2^{s.}$.
16	9 16 20.0	Im. 29 Cancri	
17	7 33 25.8	Im. 3164 B. A. C.	
29	17 52 8.5	Em. 44 Sagittarii	
March 8	6 57 51.4	Im. 750 B. A. C.	
10	9 14 16.6	Im. 75 Tauri	
	9 14 57.4	Im. * Tauri	
13	7 57 37.6	Im. λ Geminorum	May be $1^{s.}$ ± in error.
16	9 24 14.2	Im. 3398 B. A. C.	Uncertain.
April 20	10 41 50.2	Em. 49 Libræ	May be $1^{s.}$ too small.
May 17	15 49 3.8	Em. θ Libræ	
18	11 57 4.0	Em. 5555 B. A. C.	Very uncertain.
June 6	8 39 53.2	Im. 3418 B. A. C.	Good.
July 17	11 0 7.4	Em. 18 Aquarii	
1850, May 24	7 54 31.6	Im. γ Libræ	
27	10 10 49.9	Em. 17 ? Sagittarii	Clouds interfered, may be too much by $2^{s.}$.
June 12	8 28 50.7	Im. 2759 B. A. C.	
	8 28 49.4	"	Observed by H. M. Tupper.
13	8 38 28.4	Im. π^2 Cancri	
	8 38 28.2	"	Observed by J. L. Blodget.
	8 50 28.3	Im. $*^2$ Cancri	Uncertain.
	8 58 1.5	Im. $*^3$ Cancri	
	8 58 57.5	Im. $*^4$ Cancri	
Sept. 14	10 13 40.6	Im. ξ' Sagittarii	
Oct. 21	7 49 24.2	Im. 845 B. A. C.	May be too small by $1^{s.}$.

FROM A LETTER OF MR. HIND TO THE EDITOR.

Observatory, Regent's Park, London, 1851, *May* 30.

The planet which I first perceived about $12^{h.}$ $45^{m.}$ M. T. on May 19, is a bluish star of the ninth magnitude. The following are some of the positions at present in my possession.

At Regent's Park, by myself.

	Greenwich M. T.	R.A.	N. P. D.
	h. m. s.	h. m. s.	° ′ ″
May 19	13 9 36	16 4 9.61	103 23 36.3
21	11 15 39	16 2 14.16	103 26 23.1
23	11 13 48	16 0 13.67	103 29 42.9

At Berlin by Professor **Encke**.

	Berlin M. T.	α	δ
	h. m. s.	° ′ ″	° ′ ″
May 24	10 56 21.1	239 49 4.0	—13 31 24.6

At Altona.

	Altona M. T.	α	δ
	h. m. s.	h. m. s.	° ′ ″
May 26	11 20 7.1	15 57 15.24	—13 35 10.7

I have been absent from the Observatory a few days, and consequently have no very recent observations.

We propose to follow a suggestion of Sir John Herschel's and call this planet *Irene* (Εἰρήνη, Peace), the symbol to be a dove carrying an olive-branch, with a star on its head. I have no approximation to the orbit at present, but we shall doubtless know more in a very few days.

J. R. HIND.

FROM A LETTER OF DR. PETERSEN TO THE EDITOR.

Altona Observatory, 1851, *May* 27.

In case my letter sent you on Friday, May 23, with the circular announcing the discovery of another planet by Mr. Hind, may not duly arrive, I write again to-day, and can now add observations of May 24 and 26 in Altona, Berlin, and Hamburg. . . . . . [The circular contains the observations of the first night.]

Since then, I have compared the planet by the ring-micrometer with a star of the 9 magnitude, B. Z. 249, whose apparent place is assumed

	✱ α	✱ δ
	h. m. s.	° ′ ″
May 24	15 59 53.49	—13 32 2.5
26	53.51	2.5

Mr. Sonntag has also observed it with the meridian-circle. The resultant apparent positions of the planet are,

1851.	Altona M. T.	α	δ	Obs.
	h. m. s.	h. m. s.	° ′ ″	
May 24	10 10 40.4	15 59 17.85	—13 31 23.3	5
	10 39 18.8	16.26	24.3	5
	11 43 54.8	13.59	31.5	6
	11 51 24.0	15 59 13.70	13 31 30.8	M. Cir.
May 26	11 20 7.1	15 57 15.24	—13 35 10.7	8

Professor Encke has sent me the following observation.

	Berlin M. T.	α	δ	Obs.
	h. m. s.	° ′ ″	° ′ ″	
May 24	10 56 21.1	239 49 4.0	—13 31 24.6	16

The comparison-star is the same with which I compared the planet.

Professor Rümker at the Hamburg Observatory observed it as follows.

	Hamburg M. T.	α	δ	
	h. m. s.	° ′ ″	° ′ ″	
May 24	11 51 26.2	239 48 23.6	—13 31 30.2	M. Cir.

You will thus see that we have not only been industrious, but have observed pretty well; for all four observers, May 24, give almost the same position. And the assumed place of the comparison-star must be quite good, though of course it must be still better determined.

The total eclipse of the sun, July 28, which is total in many places in Europe, will probably lead to many excellent and interesting observations and remarks in physical as well as astronomical points. In Russia, observations are to be made in seventeen or eighteen different points in the path of the total phase. The Pulkowa observers go to Ostrolenska in Poland. The Königsberg astronomers have selected the four stations, Königsberg, Hela, Trunz, and Ortelsburg. Professor Airy and some other English astronomers will probably visit Norway or Sweden to observe this sublime phenomenon. As no one but myself has any official station here, I am unable to leave Altona, although the Königsbergers have invited me to come there.

A. C. PETERSEN.

IRENE.

Lieutenant Maury has communicated observations of the new planet made with the large Equatorial by Mr. Ferguson, at the Washington Observatory. The planet is estimated as of the 9.10 magnitude. It is a little larger than Weisse XV. 845, which is near it.

Date.	Washington M. T.	No. Obs.	Comparison-Star.	Irene — Star. Δ α	Irene — Star. Δ δ	α	δ
	h. m. s.			m. s	′ ″	h. m. s.	° ′ ″
June 9	10 39 45.0	8	Weisse XV. 864	—0 35.47	+6 10.99	15 44 22.83	—14 9 41.5
	11 56 23.8	10	"	—0 37.94	+6 3.42	15 44 20.36	—14 9 48.8

Adopted mean place for 1850.0 of comparison-star: —

	α	δ
	h. m. s.	° ′ ″
Weisse XV. 864	15 44 53.28	—14 15 40.45

ON A NEW METHOD OF CORRECTING LUNAR DISTANCES FOR PARALLAX AND REFRACTION.

By WILLIAM CHAUVENET,
PROFESSOR OF MATHEMATICS IN THE U. S. NAVAL ACADEMY.

[Communicated by Lieutenant Davis, Superintendent of the Nautical Almanac.]

In the year 1832, Bessel gave, in the *Astronomische Nachrichten*, a new solution of the problem of finding the longitude by lunar distances. He demonstrated the errors of previous methods, and, taking a view of the problem wholly different from that taken by all who had before investigated it, he proposed formulas by which, with a particular disposition of the ephemeris, a perfectly accurate result could be obtained. An ephemeris arranged upon his plan was immediately prepared and published by Schumacher, together with tables and practical directions for facilitating its use at sea ;* and in the hope of reaching British and American navigators, all the rules were given in the English language. The experiment, however, was unsuccessful, and after the ephemeris had reached its third year, it was abandoned. This failure is to be ascribed chiefly to the nature of Bessel's computation, which, besides being considerably longer than those in common use, required more skill in the management of trigonometric functions than was generally possessed by navigators. As delivered by its author, the method seemed simple enough to the mathematician accustomed to considering the varying signs of his functions ; but when it was reduced to a set of practical rules, dispensing with a consideration of those signs, it became embarrassing by the multiplicity of its cases. But the solution is the only complete and perfect one that has been given, and cannot be wholly laid aside. It is to be hoped that an ephemeris adapted to this method may again be established, if not for the use of all navigators, yet for those (and they are not a few) who possess the requisite skill, and who set a value upon precise results.

In the mean time I have found that something could be done towards perfecting the common methods without changing the form of the ephemeris, and without introducing any processes of a kind not familiar to practical men. The method I have proposed * is hardly more laborious than the simplest of those in common use, while it attains to that extreme precision which is required when we wish to get from our observations all that they are capable of giving. It is proper to observe, however, that Bessel's method, dispensing with the observation of the altitudes, is to be preferred for observations at night, when it is usually difficult and often impossible at sea to measure altitudes on account of the obscurity of the horizon. But with lunar distances from the sun, the object most frequently employed, there is no difficulty in obtaining the altitudes, so that for these, as well as for twilight observations of planets or stars with the moon, a short and accurate method of employing the common ephemeris is still desirable.

(*To be continued.*)

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* *Distances of the Sun and the Four Planets, Venus, Mars, Jupiter, and Saturn, from the Moon, calculated according to Mr. Bessel's Method, etc.*, (for the years 1835, 1836, 1837), by H. C. Schumacher. Copenhagen, 1834 - 36. — *Auxiliary Tables for Bessel's Method of clearing Lunar Distances.*

* I gave a brief sketch of this method at the meeting of the American Association for the Advancement of Science in August last, but without the mathematical investigation which it is the object of the present paper to supply.

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ON A NEW METHOD OF CORRECTING LUNAR DISTANCES FOR PARALLAX AND REFRACTION.

By WILLIAM CHAUVENET,
PROFESSOR OF MATHEMATICS IN THE U. S. NAVAL ACADEMY.

[Communicated by Lieutenant Davis, Superintendent of the Nautical Almanac.]

(*Continued from page 24.*)

I.

The observation is supposed to give the apparent distance and apparent altitudes of the two objects; but if the latter cannot be observed, they must, in order to apply the present method, be previously computed by the known rules. Taking at once the most general case, namely, that in which the object observed with the moon also has parallax, let us call this object "the sun." Our formulas will require no change for a planet, and for a star no other change than making its parallax zero.

Let, then,

d = apparent distance of moon's and sun's centers. (See Section IV.)
h = moon's apparent altitude.
H = sun's " "
d_1, h_1, H_1, the distance and altitudes referred to that point of the earth's axis which lies in the vertical of the observer, which point (after Bessel) we shall distinguish as the point O.

We have the known fundamental relation,

$$\frac{\cos d_1 - \sin h_1 \sin H_1}{\cos h_1 \cos H_1} = \frac{\cos d - \sin h \sin H}{\cos h \cos H}$$

and if

$$m = \frac{\sin h_1 \sin H_1}{\sin h \sin H}, \qquad n = \frac{\cos h_1 \cos H_1}{\cos h \cos H},$$

then

$$\cos d - \cos d_1 = (1-n) \cos d - (m-n) \sin h \sin H. \qquad (1)$$

Let

$$\Delta d = d_1 - d, \qquad \Delta h = h_1 - h, \qquad \Delta H = H - H_1,$$

then

$$\cos d - \cos d_1 = 2 \sin \tfrac{1}{2} \Delta d \sin (d + \tfrac{1}{2} \Delta d)$$

$$n = \frac{\cos (h + \Delta h) \cos (H - \Delta H)}{\cos h \cos H}$$

$$= \left(1 - \frac{2 \sin \frac{1}{2} \Delta h \sin (h + \frac{1}{2} \Delta h)}{\cos h}\right) \times \left(1 + \frac{2 \sin \frac{1}{2} \Delta H \sin (H - \frac{1}{2} \Delta H)}{\cos H}\right),$$

$$1 - n = \frac{2 \sin \frac{1}{2} \Delta h \sin (h + \frac{1}{2} \Delta h)}{\cos h} - \frac{2 \sin \frac{1}{2} \Delta H \sin (H - \frac{1}{2} \Delta H)}{\cos H}$$
$$+ \frac{4 \sin \frac{1}{2} \Delta h \sin \frac{1}{2} \Delta H \sin (h + \frac{1}{2} \Delta h) \sin (H - \frac{1}{2} \Delta H)}{\cos h \cos H}.$$

Also, observing the relations

$$\begin{aligned}
\sin h_1 \cos h &= \tfrac{1}{2} [\sin (2h + \Delta h) + \sin \Delta h] \\
\cos h_1 \sin h &= \tfrac{1}{2} [\sin (2h + \Delta h) - \sin \Delta h] \\
\sin H_1 \cos H &= \tfrac{1}{2} [\sin (2H - \Delta H) - \sin \Delta H] \\
\cos H_1 \sin H &= \tfrac{1}{2} [\sin (2H - \Delta H) + \sin \Delta H]
\end{aligned}$$

we find

$$m - n = \frac{\sin h_1 \cos h \sin H_1 \cos H - \cos h_1 \sin h \cos H_1 \sin H}{\sin h \cos h \sin H \cos H}$$

$$= \frac{\sin \Delta h \sin (2H - \Delta H) - \sin \Delta H \sin (2h + \Delta h)}{2 \sin h \cos h \sin H \cos H}$$

If, then, we put

$$A_1 = \frac{2 \sin \frac{1}{2} \Delta h \sin (h + \frac{1}{2} \Delta h) \cos d}{\cos h}$$

$$B_1 = -\frac{\sin \Delta h \sin (2H - \Delta H)}{2 \cos h \cos H}$$

$$C_1 = -\frac{2 \sin \frac{1}{2} \Delta H \sin (H - \frac{1}{2} \Delta H) \cos d}{2 \cos H}$$

$$D_1 = \frac{\sin \Delta H \sin (2h + \Delta h)}{2 \cos h \cos H}$$

the equation (1) becomes

$$2 \sin \tfrac{1}{2} \Delta d \sin (d + \tfrac{1}{2} \Delta d) = A_1 + B_1 + C_1 + D_1 - A_1 C_1 \sec d. \qquad (2)$$

This *rigorous* formula may be adapted for practical use in several ways requiring auxiliary tables. I proceed to give the transformation which appears to require the fewest and simplest tables.

II.

If the terms of (2) are reduced to seconds, we shall have

$$\Delta d \sin (d + \tfrac{1}{2} \Delta d) = A_1 + B_1 + C_1 + D_1 - A_1 C_1 \sin 1'' \sec d \qquad (3)$$

in which

$$\begin{aligned}
A_1 &= \frac{\Delta h}{\cos h} \,.\, \sin\left(h + \tfrac{1}{2}\Delta h\right) \cos d \\
B_1 &= -\frac{\Delta h}{\cos h} \,.\, \frac{\sin\left(2H - \Delta H\right)}{2\cos H} \\
C_1 &= -\frac{\Delta H}{\cos H} \,.\, \sin\left(H - \tfrac{1}{2}\Delta H\right) \cos d \\
D_1 &= \frac{\Delta H}{\cos H} \,.\, \frac{\sin\left(2h + \Delta h\right)}{2\cos h}\,.
\end{aligned}$$

Let

p = moon's horizontal parallax reduced to the point O. (See Section III.)

r = moon's refraction.

P, R, the same quantities for the sun; then

$$\begin{aligned}
\Delta h &= p \cos\left(h - r\right) - r \\
\Delta H &= R - P \cos\left(H - R\right).
\end{aligned}$$

The neglect of R in the term $P \cos\left(H - R\right)$ produces an error altogether inappreciable in practice; but the error produced by omitting r in the term $p \cos\left(h - r\right)$ may amount to $1''$, and we shall therefore take

$$\begin{aligned}
\cos\left(h - r\right) &= \cos h + \sin r \sin h \\
\Delta h &= p \cos h - r + p \sin r \sin h \\
&= \left(p \cos h - r\right)\left(1 + \frac{p \sin r \sin h}{p \cos h - r}\right).
\end{aligned}$$

If we develop the last term, and put

$$k = r \tan h$$

we shall have, designating the term by K,

$$K = \frac{p \sin r \sin h}{p \cos h - r} = k \sin 1''\left(1 + \frac{k}{p \sin h}\right)$$

in which p may be taken at its mean value; and since k and h decrease together, it will be found that K is nearly constant, its maximum being .000296, and its minimum .000285. A wider range will be admitted if we allow for the variations of the barometer and thermometer, and of p; but without here entering into more details, it will suffice to state that the error of the value

$$K = .00029$$

is always less than .00006 so long as $h > 5°$, and the formula

$$\Delta h = \left(p \cos h - r\right)\left(1 + K\right)$$

gives Δh within $0''.05$ at a mean state of the air, and within $0''.2$ in all cases.

Let now

$$r' = \frac{r}{\cos h}, \qquad R' = \frac{R}{\cos H}.$$

The quantities r' and R' will be given by a "Refraction Table for Lunars," which with the argument *apparent altitude* will give the refraction divided by the cosine of the altitude, and will be arranged precisely like the ordinary tables of refractions. The corrections for the barometer and thermometer may be arranged as usual in nautical tables, with the arguments *height of barometer* (or *thermometer*) and *apparent altitude*; or, which is preferable, with the refraction itself instead of the altitude, for with the latter arrangement the same table will serve to give the correction either of r or of r'.

These quantities then being substituted, the corrections of the apparent altitudes become

$$\begin{aligned}
\Delta h &= \left(p - r'\right)\left(1 + K\right) \cos h \\
\Delta H &= \left(R' - P\right) \cos H
\end{aligned}$$

and the terms of (3) become

$$\begin{aligned}
A_1 &= \left(p - r'\right)\left(1 + K\right) \sin\left(h + \tfrac{1}{2}\Delta h\right) \cos d \\
B_1 &= -\left(p - r'\right)\left(1 + K\right) \frac{\sin\left(2H - \Delta H\right)}{2\cos H} \\
C_1 &= -\left(R' - P\right) \sin\left(H - \tfrac{1}{2}\Delta H\right) \cos d \\
D_1 &= \left(R' - P\right) \frac{\sin\left(2h + \Delta h\right)}{2\cos h}\,.
\end{aligned}$$

The term $A_1\, C_1 \sin 1'' \sec d$ is very small, its maximum being only about $1''$. It is easy to obtain an approximate expression for it, and to combine it with the term A_1; for in so small a term we may take

$$C_1 = -R' \sin H \cos d = -k' \cos d$$

where $k' = R \tan H$; and without sensible error in most cases we may take $k' \sin 1'' = K$, so that

$$C_1 \sin 1'' \sec d = -K$$

and

$$A_1 - A_1\, C_1 \sin 1'' \sec d = \left(p - r'\right)\left(1 + K\right)^2 \sin\left(h + \tfrac{1}{2}\Delta h\right) \cos d.$$

The error of this evaluation of the term $A_1\, C_1 \sin 1'' \sec d$ is produced chiefly by the neglect of P, and is therefore appreciable only in the case of the planet *Venus*. If we suppose the extreme case in which P, $p - r'$, and H are *all* at their maximum values, the error in this term is

$$0''.44 \cos d$$

and since the equation (3) is yet to be divided by $\sin d$, the final error in the distance is

$$0''.44 \cot d$$

and can amount to $1''$ only when $d < 24°$. Moreover, the error is of the less importance in the case of *Venus*, because much less than the probable error of observation arising from an imperfect *bisection* of the planet's disc in the feeble telescope of the sextant.

Now let

$$\left.\begin{aligned}
A &= \left(1 + K\right)^2 . \frac{\sin\left(h + \tfrac{1}{2}\Delta h\right)}{\sin h} \\
B &= \left(1 + K\right) . \frac{\sin\left(2H - \Delta H\right)}{\sin 2H} \\
C &= \frac{\sin\left(H - \tfrac{1}{2}\Delta H\right)}{\sin H} \\
D &= \frac{\sin\left(2h + \Delta h\right)}{\sin 2h} \\
&\text{and} \\
A' &= \left(p - r'\right) A \sin h \cot d \\
B' &= -\left(p - r'\right) B \sin H \operatorname{cosec} d \\
C' &= -\left(R' - P\right) C \sin H \cot d \\
D' &= \left(R' - P\right) D \sin h \operatorname{cosec} d
\end{aligned}\right\} \quad (A)$$

then our formula (3) becomes

$$\varDelta d \,.\, \frac{\sin\,(d + \frac{1}{2}\,\Delta\,d)}{\sin\,d} = A' + B' + C' + D'.$$

Developing the first member, it becomes

$$\varDelta\,d\,\left(1 + \frac{2\,\sin\,\frac{1}{4}\,\Delta\,d\,\cos\,(d + \frac{1}{4}\,\Delta\,d)}{\sin\,d}\right)$$

so that if we put

$$x = -\,\frac{\Delta\,d^2\,\sin\,1''\,\cos\,(d + \frac{1}{4}\,\Delta\,d)}{\sin\,d}$$

or, with sufficient accuracy,

$$x = -\,\varDelta\,d^2\,\sin\,1''\,\cot\,d \qquad \textbf{(B)}$$

we have finally

$$\varDelta\,d = A' + B' + C' + D' + x. \qquad \textbf{(C)}$$

The logarithms of A, B, C, and D can be given in extremely simple tables, requiring little or no interpolation, the arguments for log A and log D being $p - r'$ and h, and those for log B and log C being $R' - P$ and H. A', B', C', and D' may then be computed with the greatest ease. The value of x can be given in a small table with the arguments $\varDelta\,d$ and d, the table being first entered with the approximate value of $\varDelta\,d = A' + B' + C' + D'$.

The advantages of the preceding process are conceived to be, — 1st. The formula is almost rigorously exact, representing the correction of distance in all practical cases within $1''$; 2d. The logarithmic computation is simple and brief; 3d. *The tabulated logarithms require no correction for the height of the barometer and thermometer.* In no one of the approximative methods in use are these features combined. Those which are based upon accurate formulas either require troublesome computations, or are shortened by the use of tables in which a mean refraction is used, and no ready method is given for correcting the logarithms in these tables for the actual state of the air. Such for the most part are Bowditch's methods. It would hardly be necessary to allude to those which are *not* based upon accurate formulas, were it not that one of this character has been adopted in a comparatively recent work of great merit in most respects, Raper's *Practice of Navigation.* The approximative method employed in that work is one received from Mendoza Rios, apparently without a very critical examination; in favorable circumstances, and particularly in low latitudes, it may be so applied as to be sufficiently accurate, but in high latitudes cases are common in which the error in the distance is $10''$, and in the *extreme* case the error is $50''$.*

If we compare our method with the shortest of the rigorous processes of spherical trigonometry, we find, — 1st. It is simpler in the logarithmic computation, requiring only four-decimal, or at most five-decimal logarithms. It is also an important simplification for the practical navigator, that the distance and altitudes are not required to be combined (to form, for example, their half sum, etc.), previously to referring to the tables, as in almost every other method, approximative or rigorous. 2d. It separates the principal corrections for the moon and sun, the principal correction for the moon being $A' + B'$, and that for the sun being $C' + D'$. The advantage of this separation appears in the method to be given for computing the correction for contraction of the moon's and sun's semidiameters by refraction. (Section IV.)

III.

*Correction for the Compression of the Earth.** — In the preceding investigation d_1, h_1, H_1, represent the distance and altitudes referred to the point O. (Section I.) This reference may be made in the case of the moon by employing a horizontal parallax equal to her equatorial horizontal parallax increased in the ratio $\frac{a_1}{a}$, a denoting the equatorial radius of the earth, and a_1 the distance of the observer from the point O; which distance is the normal of the spheroid, and is expressed by

$$a_1 = \frac{a}{\sqrt{(1 - \varepsilon^2 \sin^2 \varphi)}}$$

where ε = eccentricity of the meridian,
φ = geodetic latitude.

This process is subject to a slight theoretical error, the amount of which will presently be estimated.

If we denote by $-\,a\,i$ the distance from the center of the earth to the point O, and put

π = moon's equatorial horizontal parallax,
ϱ = distance of the moon from the center of the earth,
δ = moon's geocentric declination,
d' = angular distance of the moon and sun referred to the center of the earth,
π_1, ϱ_1, δ_1, d_1, = the same quantities referred to the point O,
$\varDelta$ = sun's declination,
a = difference of right ascensions of the moon and sun,

---

* The development of $\varDelta\,d$ in series as far as the terms of the second order is

$$\varDelta\,d = -\,\varDelta\,h\,\cos\,q + \varDelta\,H\,\cos\,Q + \frac{\Delta\,h^2}{2}\,.\,\frac{\sin^2 q}{\tan\,d}$$
$$+\,\varDelta\,h\,.\,\varDelta\,H\,.\,\frac{\sin\,q\,\sin\,Q}{\sin\,d} + \frac{\Delta\,H^2}{2}\,.\,\frac{\sin^2\,Q}{\tan\,d}$$

in which q and Q denote the angles included between d and the zenith-distances of the moon and sun respectively. In the method referred to in the text, the formula employed is equivalent to

$$\varDelta\,d = -\,\varDelta\,h\,\cos\,q + \varDelta\,H\,\cos\,Q + \frac{\Delta\,h^2}{2}\,.\,\frac{\sin^2 q}{\tan\,d}$$

so that the error E in the distance is

$$E = -\left(\varDelta\,h\,.\,\varDelta\,H\,.\,\frac{\sin\,q\,\sin\,Q}{\sin\,d} + \frac{\Delta\,H^2}{2}\,.\,\frac{\sin^2\,Q}{\tan\,d}\right).$$

If $h = 10°$, $H = 10°$, $d = 40°$, $p = 60'$, (which is far from being an extreme case,) we find $E = -\,10''.4$. In the extreme case to which, according to the arrangement of Raper's tables and rules, the method may be extended, — namely, $h = 5°$, $H = 5°$, $d = 13°$, $p = 61'\ 30''$, — the refraction being at a mean, we find $E = -\,43''$; and since we may suppose the refraction to be increased by as much as one sixth of its amount, we may even have $E = -\,50''$.

Bowditch's "First Method" is more accurate as to the formula, including one term more of the above development, but, being adapted for use only upon the supposition of a mean state of the air, is subject to even greater errors than the method just examined.

* For the sake of completeness I have thought it proper to treat of this correction fully; but the method followed, it need hardly be observed, is not new in principle, although it is not at present in use among navigators.

then we have the known formulas

$$a\,i = \frac{a\,\epsilon^2 \sin \varphi}{\surd\,(1 - \epsilon^2 \sin^2 \varphi)}$$

$$\left.\begin{aligned} \varrho_1 \cos \delta_1 &= \varrho \cos \delta \\ \varrho_1 \sin \delta_1 &= \varrho \sin \delta + a\,i \end{aligned}\right\} \qquad (4)$$

whence, very nearly,

$$\varrho_1 = \varrho + a\,i \sin \delta \qquad (5)$$

$$\sin \pi_1 = \frac{a_1}{\varrho_1} = \frac{a_1}{\varrho}\left(1 + \frac{a\,i \sin \delta}{\varrho}\right)^{-1}$$

$$= \frac{a_1}{a} \sin \pi \, (1 - i \sin \pi \sin \delta + \&c.)$$

or, with extreme accuracy,

$$\pi_1 = \pi \,.\, \frac{a_1}{a} - \frac{\epsilon^2 \sin^2 \pi \sin \varphi \sin \delta}{\sin 1''}\,.$$

The maximum value of the last term is only 0″.2, so that in the present application we may take

$$\pi_1 = \pi \,.\, \frac{a_1}{a}$$

and the correction of π,

$$\pi_1 - \pi = \pi \,.\, \frac{a_1 - a}{a}$$

may be given in a small table with the arguments φ and π. The similar correction of the sun's or a planet's parallax is insensible in practice.

If, then, in the computation of (**A**), (**B**), and (**C**), we employ for p the value $p = \pi_1$ we obtain d_1. To reduce finally to the center of the earth, we have

$$\left.\begin{aligned} \cos d' &= \sin \Delta \sin \delta + \cos \Delta \cos \delta \cos \alpha \\ \cos d_1 &= \sin \Delta \sin \delta_1 + \cos \Delta \cos \delta_1 \cos \alpha \end{aligned}\right\} \qquad (6)$$

from which combined with (4) we find

$$\varrho \cos d' - \varrho_1 \cos d_1 = -a\,i \sin \Delta$$

or by (5)

$$\cos d' - \cos d_1 = \frac{a\,i}{\varrho}(\sin \delta \cos d_1 - \sin \Delta)$$

$$2 \sin \tfrac{1}{2}(d' + d_1) \sin \tfrac{1}{2}(d' - d_1) = i \sin \pi \,(\sin \Delta - \sin \delta \cos d_1)$$

and with great accuracy for our present purpose,

$$d' - d_1 = \frac{i\,\pi \sin \Delta}{\sin d_1} - \frac{i\,\pi \sin \delta}{\tan d_1} \qquad (\mathbf{D})$$

a formula easily put into tables, especially if we employ a mean value of π which will never produce an error of more than about 1″. If any one, however, desires to compute this correction directly, it may be done by the formula

$$d' - d_1 = N\,\pi \sin \varphi \,.\, \frac{\sin \Delta}{\sin d_1} - N\,\pi \sin \varphi \,.\, \frac{\sin \delta}{\tan d_1} \qquad (\mathbf{D}^*)$$

in which

$$N = \frac{\epsilon^2}{\surd\,(1 - \epsilon^2 \sin^2 \varphi)}$$

and we may employ without sensible error the value of N corresponding to $\varphi = 45°$, or $\log N = 7.8170$, the compression being $\frac{1}{300}$.

The computation of this correction would be rendered at once simple and accurate in practice, if the ephemeris contained the log of

$$N\,\pi\left(\frac{\sin \Delta}{\sin d'} - \frac{\sin \delta}{\tan d'}\right) = N'$$

(which is equivalent to a logarithm introduced by Bessel into his ephemeris for the same purpose), for we should then have

$$d' - d_1 = N' \sin \varphi. \qquad (7)$$

IV.

Corrections for the Contraction of the Moon's and Sun's Semidiameters by Refraction.—The apparent distance of the centers of the moon and sun has been supposed above to have been found in the usual manner from the observed distance of the limbs, by adding the apparent semidiameters; or when the moon has been observed with a planet or star, by adding or subtracting the moon's semidiameter alone, according as her nearest or farthest limb has been observed. At low altitudes the elliptical figure of the disc must be taken into consideration; for the refraction being different at points of the limb which have different altitudes, the result is an apparent contraction of every semidiameter, the vertical ones being the most, and those perpendicular to the vertical the least contracted.* It becomes necessary to obtain a general expression for the contraction of that semidiameter which lies in the direction of the distance, and makes an angle q with the vertical circle. If we put

s = horizontal semidiameter of the moon + the augmentation,
s_0 = the apparent vertical semidiameter,
s' = “ inclined “
Δs_0 = contraction of vertical “ $= s - s_0$
$\Delta s'$ = “ inclined “ $= s - s'$
Δr = difference of refractions at the center of the moon and the observed point on the limb,

we have nearly $\Delta s' = \Delta r \cos q.$

But the apparent altitude of the center being h, Δs_0 is the difference of refractions at the apparent altitudes h and $h + s_0$, while Δr is the difference of refractions at h and $h + s' \cos q$, whence

$$\Delta s_0 : \Delta r = s_0 : s' \cos q$$

$$\Delta r = \frac{s'}{s_0} \,.\, \Delta s_0 \cos q = \Delta s_0 \cos q \text{ (nearly)}$$

$$\Delta s' = \Delta s_0 \cos^2 q \qquad (8)$$

a known formula, which agrees very nearly with the hypothesis that the figure of the disc is an ellipse. It is evident, however, that the lower half of the disc is more flattened than the upper half; but if Δs_0 be taken as the *mean* of the contrac-

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* It is usually stated that the semidiameter which is perpendicular to the vertical circle is *not* contracted; but in fact it is contracted by a small quantity, which is nearly the same at all altitudes; for if Z denote the azimuthal angle between the center and the extremity of a horizontal semidiameter, s the true and s' the apparent horizontal semidiameter, we have

$$\tan Z = \frac{\tan s}{\cos (h - r)} = \frac{\tan s'}{\cos h}$$

whence we easily deduce

$$s - s' = s'\,r \sin 1'' \tan h = s'\,k \sin 1''$$

in which $k = r \tan h$ is nearly constant. If $s = 16'$ we have for $h = 5°$, $s - s' = 0''.24$; and for $h = 90°$, $s - s' = 0''.27$. This small quantity is not taken into account in the investigation in the text.

tions of the upper and lower vertical semidiameters, the preceding formula will be in error only 0″.4 at the altitude 10°, and 1″.2 at 5°; the maximum values of $\varDelta s_0$ at those altitudes being respectively 10″ and 30″. The changes of the thermometer and barometer may also sensibly affect the value of $\varDelta s_0$ at low altitudes, but only by 4″ in the improbable case of the *highest barometer* and *lowest thermometer*, and $h = 5°$. It will hardly be necessary to attend to this small error in practice; nevertheless, it can readily be done without any further reference to the refraction tables, for the computer will already have before him r_0' the mean value of r', and $\varDelta r_0'$ the sum of the corrections of r_0' for barometer and thermometer; so that he may find at once the proportional correction of $\varDelta s'$, which is $\varDelta s' . \frac{\Delta r'}{r_0'}$.

Now the angle q is given by the formula

$$\cos q = \frac{\sin H - \sin h \cos d}{\cos h \sin d}$$

and we have from the formulas (**A**)

$$\frac{B'}{B(p-r')\cos h} = -\frac{\sin H}{\cos h \sin d}, \quad \frac{A'}{A\,(p-r')\cos h} = \frac{\sin h \cos d}{\cos h \sin d},$$

so that

$$\cos q = -\left(\frac{B'}{B} + \frac{A'}{A}\right)\frac{1}{(p-r')\cos h}.$$

If we assume $A = 1$, $B = 1$, we shall have

$$\cos q = -\frac{A' + B'}{(p-r')\cos h}$$

$$\varDelta s' = \varDelta s_0 . \frac{(A'+B')^2}{(p-r')^2 \cos^2 h} \qquad (\mathbf{E})$$

which is easily put into tables. A table with the arguments h and $p - r'$ may give the value of

$$\frac{\Delta s_0}{(p-r')^2 \cos^2 h}$$

and a second table with the arguments $A' + B'$ and "the number from the first table" may give $\varDelta s'$.

In order to ascertain the degree of accuracy of the formula (**E**), we observe that the errors in $\cos q$ produced by taking $A = 1$, $B = 1$, are

$$e = (A-1)\frac{\tan h}{\tan d}, \qquad e' = (1-B)\frac{\sin H}{\cos h \sin d};$$

the errors in $\cos^2 q$ are

$$2\,e \cos q \qquad \text{and} \qquad 2\,e' \cos q$$

and the errors in $\varDelta s'$ are therefore

$$e_1 = \frac{2\,\Delta s_0\,(A-1)\tan h \cos q}{\tan d}, \quad e_1' = \frac{2\,\Delta s_0\,(1-B)\sin H \cos q}{\cos h \sin d}.$$

The greatest values of e_1 and e_1' at different altitudes are shown as follows, taking $\cos q = 0$, $H = 90°$, in order to represent the extreme cases:—

h	$e_1 \tan d$	$e_1' \sin d$
5°	0″.45	0″.02
10°	0″.16	0″.00
15	.08	.00
30	.02	.00
50	.00	.00

It appears, therefore, that the error of the formula (**E**), like that of (8), becomes sensible only at those low altitudes where extreme precision is unattainable on account of the uncertainty of the refraction. We may therefore safely employ it as sufficiently accurate for all cases.

When the sun is observed with the moon, a similar correction must be applied to his semidiameter. If

Q = angle at the sun,
S = true semidiameter of the sun,
S_0 = apparent vertical semidiameter of the sun,
S' = " inclined " "
$\varDelta S_0$ = contraction of vertical semidiameter $= S - S_0$,
$\varDelta S'$ = " inclined " $= S - S'$,

then as above

$$\varDelta S' = \varDelta S_0 \cos^2 Q$$

$$\cos Q = \frac{\sin h - \sin H \cos d}{\cos H \sin d} = \left(\frac{C'}{C} + \frac{D'}{D}\right)\frac{1}{(R'-P)\cos H}$$

and assuming $C = 1$, $D = 1$, we have

$$\cos Q = \frac{C' + D'}{(R'-P)\cos H}$$

$$\varDelta S' = \varDelta S_0 . \frac{(C'+D')^2}{(R'-P)^2 \cos^2 H} \qquad (\mathbf{F})$$

which is even more accurate than (**E**), and is put into tables in the same manner.

The corrections $\varDelta s'$ and $\varDelta S'$ should strictly be applied to the semidiameters, and should appear in the value of d employed in the computation of $\varDelta d$; but since the values of A', B', C', and D' are required in finding $\varDelta s'$ and $\varDelta S'$, we have to employ a value of d which may in extreme cases be in error by about 30″. This produces a small error in each of the terms A', B', C', D', which could in practice be eliminated only by repeating the computation with the corrected value of d. But this repetition is unnecessary, as the error in $\varDelta d$ is rarely more than 0″.5; and it will suffice to apply $\varDelta s'$ and $\varDelta S'$ directly to d_1.

In order, however, to show generally the effect upon $\varDelta d$ of small errors in d, let us differentiate the equation (**C**), regarding the term x (of the second order) as constant, and taking $A = 1$, $B = 1$, $C = 1$, $D = 1$ (which also amounts to considering terms of the second order as constant). We find

$$\delta \varDelta d = -\frac{(p-r')(\sin h - \sin H \cos d)\sin 1''\,\delta d}{\sin^2 d} + \frac{(R'-P)(\sin H - \sin h \cos d)\sin 1''\,\delta d}{\sin^2 d}$$

or

$$\delta \varDelta d = -[(p-r')\cos Q \cos H - (R'-P)\cos q \cos h]\frac{\sin 1''\,\delta d}{\sin d}. \qquad (9)$$

This formula shows at once that the maximum of $\delta \Delta d$ occurs when the two bodies are in the same vertical circle, the moon being the higher body; for this condition gives $\cos q = -1$, $\cos Q = 1$, so that the two terms obtain the same sign, and at the same time $p - r'$ and $R' - P$ have their greatest values. In this position, we have $d = h - H$, and the formula for the maximum of $\delta \Delta d$ is therefore

$$\delta_0 \Delta d = -[(p - r') \cos H + (R' - P) \cos h] \frac{\sin 1'' \, \delta d}{\sin (h - H)} . \qquad (10)$$

The following table shows the maximum effect upon Δd of an error of 1′ in d, computed by formula (10), for the several values of h and H; the least value of $h - H$ $(= d)$ being 20°.

H	h							
	25°	35°	45°	55°	65°	75°	85°	90°
5°	3″.6	2″.4	1″.9	1″.5	1″.3	1″.2	1″.1	1″.1
15		3.2	2.2	1.7	1.4	1.2	1.1	1.0
25			2.9	2.0	1.5	1.3	1.1	1.0
35				2.6	1.8	1.4	1.1	1.0
45					2.2	1.5	1.2	1.0
55						1.8	1.2	1.0
65							1.3	0.9

This table of *extreme* errors shows clearly enough that the error arising from the neglect of $\Delta s'$ and $\Delta S'$ in the value of d employed in computing Δd, is too small to require any departure from the process already indicated. For the navigator must bear in mind that all observations at very low altitudes are subject to two principal sources of error; — 1st, the uncertainty of the refraction, which no process of calculation can eliminate; and 2d, the imperfect definition of the limb of the moon or sun in the vicinity of the horizon. If a method of computation involves only errors which in every case are less than these unavoidable errors, it satisfies the essential condition of a good method.

FROM A LETTER OF PROFESSOR SAWITSCH, DIRECTOR OF THE ST. PETERSBURG OBSERVATORY, TO THE EDITOR.

St. Petersburg, 1851, *May* 27.

Accompanying this are some observations which I send for insertion in your *Astronomical Journal*. They give the apparent positions of the centers, at the time of their transit over the St. Petersburg meridian.

OPPOSITION OF SATURN, 1849.

Date.	♄ α	Obs. — Naut. Alm.	♄ δ	Obs. — Naut. Alm.	Comparison-Stars.
1849.	h. m. s.	s.	° ′ ″	″	
Sept. 24	0 21 44.23	+1.24	—0 31 30.4	+40.5	33 *Piscium*
26	21 10.33	1.68	35 18.7	38.9	and
Oct. 3	19 10.18	1.26	48 23.2	36.5	20 *Ceti.*
6	0 18 19.62	+1.60	—0 53 47.6	+38.5	

The observed declinations are freed from the effects of parallax and refraction.

OPPOSITION OF URANUS, 1849.

Date.	⛢ α	Obs. — Naut. Alm.	⛢ δ	Obs. — Naut. Alm.	Comparison-Stars.
1849.	h. m. s.	s.	° ′ ″	″	
Oct. 3	1 32 55.63	—10.33	+9 4 3.6	+16.8	*μ Piscium* and
15	1 31 7.07	—10.18	+8 53 30.8	+11.1	*v Piscium.*

The observed declinations are freed from the effects of parallax and refraction.

MARS, 1849.

Date.	♂ α	Obs. — Naut. Alm.	♂ δ	Comparison-Stars.
1849.	h. m. s.	s.	° ′ ″	
Dec. 21	5 37 19.89	+1.85	+26 30 14.0	125 *Tauri.*
23	33 58.94	1.95	31 0.1	β and 118 *Tauri.*
26	5 29 9.98	+1.56	+26 29 8.4	β and 118 *Tauri.*

The observed declinations are corrected for refraction only; no regard having been had to the effect of parallax.

VESTA, 1850.

Date.	⚶ α	Obs. — Naut. Alm.	⚶ δ	Obs. — Naut. Alm.	Comparison-Stars.
1850.	h. m. s.	s.	° ′ ″	″	
Jan. 14	7 21 53.19	—1.77	+23 41 32.6	+18.6	δ *Geminorum.*
15	7 20 46.66	—2.01	+23 46 29.9	+18.5	"

The observed declinations are corrected for parallax and refraction.

JUPITER, 1850.

Date.	♃ α	Obs. Naut. Alm.	♃ δ	Obs. — Naut. Alm.	Comparison-Stars.
1850.	h. m. s.	s.	° ′ ″	″	
March 12	11 16 56.12	+0.87	+6 16 6.3	—4.4	π *Virginis.*
15	, 15 30.53	0.98	25 11.6	4.8	π *Virginis* and β *Leonis.*
17	11 14 33.96	+0.95	+6 3 10.7	—3.0	" " "

OPPOSITION OF NEPTUNE, 1850.

Date.	Ψ α	Ψ δ	Obs. — Walker's Ephemeris. Δα	Δδ	Comparison-Stars.
1850.	° ′ ″	° ′ ″	″	″	
Sept. 7	337 29 38.1	—10 17 16.4	+3.8	—1.5	
10	25 2.6	19 2.0	+1.0	—0.9	
11	23 32.8	19 38.4	+0.7	—2.0	α, θ, σ, and
13	20 33.3	20 47.4	0.0	—1.1	λ *Aquarii.*
14	19 3.3	21 22.4	—0.3	—1.5	
17	14 41.1	23 2.9	0.0	+0.2	
20	337 10 19.1	—10 24 44.8	—5.7	—1.8	

QUADRATURE OF NEPTUNE, 1850.

Date.	Ψ α	Ψ δ	Obs. — Walker's Ephemeris. Δα	Δδ	Comparison-Star.
1850.	° ′ ″	° ′ ″	″	″	
Nov. 29	336 28 17.0	—10 40 7.7	— 7.6	—4.4	
Dec. 2	29 50.0	39 27.3	— 1.8	—1.2	λ *Aquarii.*
5	336 31 28.2	—10 38 42.3	—10.1	—0.3	

The observed declinations are corrected for parallax and refraction.

The positions of the comparison-stars are taken from the Catalogue of the British Association.

The agreement of the Ephemeris of *Neptune*, based on the elements of Mr. WALKER and Professor PEIRCE's values for the perturbations, agree admirably with the observations. I have lately, also, computed the secular variations of the elements of *Neptune*.

A. SAWITSCH.

LETTER FROM PROFESSOR RÜMKER TO THE EDITOR.

Hamburg, 1851, *June* 6.

I BEG leave to communicate to you the following observations.

ASTRÆA.

1851.	Hamburg M. T.	⚓ α	⚓ δ	Comp.	1851.	Hamburg M. T.	⚓ α	⚓ δ	Comp.
	h. m. s.	° ′ ″	° ′ ″			h. m. s.	° ′ ″	° ′ ″	
May 4	10 36 59.0	217 33 7.3	—5 29 11.6	9	May 10	10 22 39.3	216 16 46.0	—5 7 3.1	23
7	10 12 15.3	216 51 22.5	5 17 27.3	2	17	10 2 51.3	214 56 56.6	4 48 14.8	18
8	9 52 0.5	216 41 57.3	—5 13 56.9	20	21	9 54 51.4	214 17 14.0:	—4 41 16.3	2

The declinations are not corrected for parallax.

Mean Places for January 0, 1851, *of Stars in the Path of Astræa, deduced from Observations with the Meridian-Circle.*

* α	An. Var	* δ	An. Var.	* α	An. Var.	* δ	An. Var.
h. m. s.	s.	° ′ ″	″	h. m. s.	s.	° ′ ″	″
14 16 28.20	3.131	—4 38 35.0	—16.60	14 25 22.13	3.142	—5 7 56.6	—16.15
14 18 43.78	3.135	4 49 1.1	16.50	14 27 37.53	3.143	5 10 39.6	16.04
14 49 27.65	3.136	4 50 23.5	16.16	14 31 10.34	3.144	—5 8 23.4	—15.85
14 25 18.87	3.138	—4 49 12.5	—16.15				

THE NEW PLANET IRENE, DISCOVERED BY MR. HIND.

1851.	Hamburg M. T.	α	δ	1851.	Hamburg M T	α	δ
	h m. s.	° ′ ″	° ′ ″		h. m. s.	° ′ ″	° ′ ″
May 24	10 39 0.7	239 49 12.8	—13 31 36.0 ?	May 30	13 26 42.6	238 19 7.7	—13 43 30.2
	11 51 26.2	239 48 23.6	13 31 30.2 M. Cir.	31	10 19 27.2	238 6 42.6	13 45 29.8
26	10 25 51.3	239 19 24.6	13 35 2.8		11 17 6.6	238 6 3.5	13 45 38.8 M. Cir.
	11 41 36.0		13 35 20.3 M. Cir.	June 1	10 16 22.0	237 52 42.2	13 47 53.3
27	10 16 13.3	239 4 44.1	13 36 59.8		11 12 11.4	237 51 58.1	13 47 54.3 M. Cir.
	11 36 40.8	239 3 50.8	13 37 15.2 M. Cir.	4	10 22 43.5	237 10 45.8	13 56 32.8
28	10 25 46.4	238 49 26.4	13 39 4.0		10 57 42.0	237 10 41.4	—13 56 41.6 M. Cir.
	11 31 46.5	238 49 11.4	—13 39 9.3 M. Cir.				

The following elements and ephemeris of this planet have been computed from observations in London, May 19, the mean of the Berlin and Hamburg observations, May 21, and the Berlin observation of May 31, by Mr. E. Vogel and by my son, who is now studying astronomy in Berlin.

The orbit represents the middle place as follows: —

R. — B.

$\Delta\alpha = +0''.05$

$\Delta\delta = -0.08$

Irene, May 24.0, 1851, Mean Berlin Time.

M	42° 4′ 48″.98	
π	183 54 29.82	Mean Equinox, Jan. 0, 1851.
☊	87 58 59.38	
i	8 34 49.0	
φ	9 46 35.51	
Log e	9.2299526	
Log a	0.4070989	
Log μ	2.9393582	

Ephemeris for 10h. *Mean Berlin Time.*

1851.	α	δ	Log △	1851.	α	δ	Log △
	h. m. s.	° ′			h m. s.	° ′	
June 1	15 51 31	—13 47.8	0.10934	June 18	15 38 32	—14 39.1	
2	50 35	50.2		19	38 0	42.9	
3	49 40	52.7		20	37 29	46.7	
4	48 47	55.2		21	36 59	50.6	0.14863
5	47 55	13 57.8	0.11511	22	36 32	54.6	
6	47 4	14 0.5		23	36 6	14 58.7	
7	46 13	3.3		24	35 42	15 2.8	
8	45 24	6.2		25	35 20	6.9	0.15908
9	41 36	9.1	0.12202	26	35 0	11.2	
10	43 50	12.1		27	34 41	15.5	
11	43 6	15.2		28	34 23	19.9	
12	42 22	18.4		29	34 8	24.3	0.17011
13	41 40	21.7	0.12998	30	33 55	28 8	
14	40 59	25.0		July 1	33 41	33.4	
15	40 20	28.5		2	33 34	38.0	
16	39 43	32.0		3	15 33 26	—15 42.7	0.18161
17	15 39 7	—14 35.5	0.13889				

C. RÜMKER.

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THE

ASTRONOMICAL JOURNAL.

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DETERMINATION OF THE LONGITUDE OF CAMP RILEY,

NEAR THE INITIAL POINT OF THE BOUNDARY LINE BETWEEN THE UNITED STATES AND MEXICO ON THE PACIFIC COAST.

By MAJOR W. H. EMORY,

LATE ASTRONOMER TO THE COMMISSION, AND ACTING COMMISSIONER.

[Communicated by Authority of the Hon. A. H. H. Stuart, Secretary of the Interior.]

I. *Moon-Culminations observed with a 46-inch Transit, by* Troughton *and* Simms.

Date.	Object.	Observed α			Tab. α	No. of Wires.
1849.		h.	m.	s.	s.	
July 27	Moon I. L.	15	2	33.63		3
	β Libræ	15	8	55.47	55.00	6
	α Serpentis	15	36	51.36	51.69	7
	θ Libræ	15	45	15.99	16.14	7
28	α Serpentis	15	36	51.59	51.67	7
	θ Libræ	15	45	16.31	16.13	6
	Moon I. L.	15	51	50.08		7
	β' Scorpii	15	56	42.45	42.01	7
	δ Ophiuchi	16	6	28.47	28.16	7
	α Scorpii	16	19	11.24	11.87	7
	5579 B. A. C.	16	32	53.02	53.11	7
	η Ophiuchi	17	1	45.66	45.80	5
29	Moon I. L.	16	41	53.39		6
	Anonymous	17	2	21.80		5
30	5579 B. A. C.	16	32	53.23	53.08	6
	η Ophiuchi	17	1	45.54	45.78	7
	Moon I. L.	17	32	52.98		7
31	5579 B. A. C.	16	32	52.96	53.07	7
	a Herculis	17	7	47.92	47.85	7
	Moon I. L.	18	24	40.34		7
	a Lyræ	18	31	51.99	51.95	2
Aug. 2	μ' Sagittarii	18	4	46.51	46.69	6
	ζ Aquilæ	18	58	30.41	30.65	7
	ϱ' Sagittarii	19	12	57.69	57.54	7
	e' Sagittarii	19	31	7.03	6.73	7
	g Sagittarii	19	49	25.86	25.81	6
	Moon I. L.	20	9	23.89		7
	ϱ Capricorni	20	20	17.24	17.31	7
	μ Aquarii	20	44	33.05	33.08	7
3	α' Capricorni	20	9	19.27	19.19	5
	α^2 Capricorni	20	9	42.77	43.06	5
	ϱ Capricorni	20	20	17.25	17.29	7
	η Capricorni	20	55	51.27	50.99	4
	Moon I. L.	21	1	36.41		2
26	η Ophiuchi	17	1	45.17	45.42	7
	α Herculis	17	7	47.58	47.47	7
	Moon I. L.	17	13	8.85		7
	58 Ophiuchi	17	34	24.96	25.42	4
1849.		h.	m.	s.	s.	
Aug. 26	μ' Sagittarii	18	4	46.67	46.43	4
	λ Sagittarii	18	18	42.00	41.65	7
	α Lyræ	18	31	51.47	51.55	7
	ν' Sagittarii	18	45	5.84	5.73	7
	ζ Aquilæ	18	58	30.43	30.45	7
27	η Ophiuchi	17	1	45.43	45.40	7
	α Herculis	17	7	47.27	47.45	7
	θ Ophiuchi	17	12	46.62	46.74	7
	α Ophiuchi	17	27	57.35	57.36	7
	58 Ophiuchi	17	35	25.32	25.40	7
	4 Sagittarii	17	50	37.03	36.97	7
	Moon I. L.	18	4	35.59		7
	λ Sagittarii	18	18	41.75	41.64	7
	ζ Aquilæ	18	58	30.61	30.43	7
28	μ' Sagittarii	18	4	46.37	46.40	7
	λ Sagittarii	18	18	41.56	41.62	6
	α Lyræ	18	31	51.46	51.51	7
	Moon I. L.	18	56	36.37		6
	π Sagittarii	19	0	49.64	49.46	4
	γ Aquilæ	19	39	7.24	7.28	2
29	4 Sagittarii	17	50	36.16	36.94	7
	μ' Sagittarii	18	4	46.07	46.39	7
	λ Sagittarii	18	18	41.55	41.61	7
	o Sagittarii	18	55	40.76	40.62	3
	ζ Aquilæ	18	58	30.41	30.41	4
	ϱ' Sagittarii	19	12	57.92	57.37	4
	δ Aquilæ	19	17	54.86	55.44	6
	γ Aquilæ	19	39	7.08	7.28	7
	Moon I. L.	19	48	59.05		7
	α' Capricorni	20	9	19.69	19.15	6
	α^2 Capricorni	20	9	43.79	43.02	5
	β Capricorni	20	12	33.98	34.12	7
Sept. 3	π Sagittarii	19	0	49.48	49.38	7
	ϱ' Sagittarii	19	12	57.16	57.30	7
	δ Aquilæ	19	17	55.16	55.38	7
	γ Aquilæ	19	39	7.19	7.22	7
	α Aquilæ	19	43	27.32	27.35	6
	g Sagittarii	19	49	25.51	25.67	7

Date.	Object.	Observed α			Tab. α	No. of Wires.
1849.		h.	m.	s.	s.	
Sept. 3	α Capricorni	19	9	19.13	19.11	7
	α^2 Capricorni	20	9	42.91	42.98	7
	λ Aquarii	22	44	46.88	46.84	7
	α Piscis Aust.	22	49	20.46	20.56	7
	α Pegasi	22	57	17.50	17.47	7
	φ Aquarii	23	6	32.67	32.82	7
	96 Aquarii	23	11	37.01	36.83	5
	ι Piscium	23	32	14.12	13.97	7
	20 Piscium	23	40	13.66	13.48	7
	27 Piscium	23	50	59.28	59.34	7
	33 Piscium	23	57	38.98	39.17	7
	α Andromedæ	0	0	38.52	38.69	4
	γ Pegasi	0	5	30.75	30.81	7
	Moon II. L.	0	12	5.63		7
	10 Ceti	0	19	55.75	55.53	5
	13 Ceti	0	27	31.83	31.17	7
	β Ceti	0	36	2.81	2.91	6
	δ Piscium	0	40	54.05	53.87	7
	20 Ceti	0	45	20.13	20.19	7
4	27 Piscium	23	50	59.33	59.35	7
	33 Piscium	23	57	39.12	39.10	7
	γ Pegasi	0	5	30.82	30.83	7
	10 Ceti	0	18	55.82	55.54	7
	13 Ceti	0	27	31.33	31.18	6
	β Ceti	0	36	3.04	2.93	7
	δ Piscium	0	40	53.92	53.88	7
	ε Piscium	0	55	9.45	9.34	7
	e Piscium	1	0	38.45	39.05	7
	Moon II. L.	1	4	59.35		6
	μ Piscium	1	22	19.32	19.16	7
	ν Piscium	1	33	37.18	37.19	7
	ο Piscium	1	37	28.32	27.94	5
	φ Phœnicis	1	48	7.75	8.00	5
	α Arietis	1	58	42.81	43.07	7
	μ Fornacis	2	6	17.21	17.34	7
5	10 Ceti	0	18	55.84	55.55	7
	13 Ceti	0	27	31.45	31.19	7
	θ′ Ceti	1	16	30.97	31.07	7
	μ Piscium	1	22	19.21	19.17	7
	ν Piscium	1	33	37.25	37.20	7
	ο Piscium	1	37	28.12	27.95	7
	Moon II. L.	1	59	6.26		7
	ξ Ceti	2	5	2.45	2.74	7
	ξ^2 Ceti	2	20	10 35	10.73	7
24	λ Sagittarii	18	18	41.20	41.13	7
	Moon I. L.	18	35	7.81		7
	ν′ Sagittarii	18	45	5.23	5.25	7
	ο Sagittarii	18	55	39.83	40 09	2
	α Aquilæ	19	43	27.08	27.05	7
27	ζ Aquilæ	18	58	29.81	29.92	5
	β′ Sagittarii	19	11	48.88	18.88	7
	δ Aquilæ	19	17	55.08	55.01	7
	β Cygni	19	24	39 42	39.78	7
	n^2 Sagittarii	19	27	33.05	33.09	7
	γ Aquilæ	19	39	6.57	6.86	7
	β Capricorni	20	12	33.85	33.68	7
	π Capricorni	20	18	42.59	42.82	4
	υ Capricorni	20	31	29.17	29.46	7
	ε Aquarii	20	39	32.37	32.20	7
	μ Aquarii	20	44	33.10	32.85	6
	η Capricorni	20	55	50.72	50.81	7
	ν Aquarii	21	1	21.43	21.33	7
Sept. 27	ζ Cygni	21	6	33.22	33.25	7
	Moon I. L.	21	11	7.54		7
28	ζ Cygni	21	6	33.24	33.23	7
	ι Capricorni	21	13	52.39	52 38	7
	β Aquarii	21	23	38.95	38.96	6
	Moon I. L.	22	3	8.07		7
29	ζ Cygni	21	6	33.22	33.21	6
	β Aquarii	21	23	38.33	38.95	6
	γ Capricorni	21	31	45.76	45.71	7
	δ Capricorni	21	38	44.92	44.65	7
	ι Aquarii	21	58	19.27	19.27	7
	θ Aquarii	22	8	54.52	54.42	7
	γ Aquarii	22	13	54.10	54.07	7
	σ Aquarii	22	22	41.72	41.78	7
	ζ Pegasi	22	33	58.90	58.77	7
	λ Aquarii	22	41	46.91	46.84	7
	α Piscis Aust.	22	49	20.57	20.56	7
	Moon I. L.	22	55	17.04		7
	ψ^3 Aquarii	23	11	9.06	9.04	7
30	λ Aquarii	22	41	47.09	46.85	7
	α Piscis Aust.	22	49	20.31	20.56	7
	α Pegasi	22	57	17.49	17.49	7
	Moon I. L.	23	47	51.60		7
Oct. 23	γ Aquilæ	19	39	6.48	6.38	7
	α Aquilæ	19	43	26.39	26.53	7
	g Sagittarii	19	49	24.84	24.88	6
	Moon I. L.	19	57	17.24		7
	α^2 Capricorni	20	9	42.03	42.23	7
	β Capricorni	20	12	33.27	33.34	7
	π Capricorni	20	18	42.37	42.38	7
	υ Capricorni	20	31	29.00	29.03	7
25	μ Aquarii	20	44	32.67	32.42	7
	η Capricorni	20	55	50.51	50.36	7
	ν Aquarii	21	1	23.05	23.91	7
	29 Capricorni	21	7	25.23	25.23	7
	ι Capricorni	21	13	52.10	52.06	7
	β Aquarii	21	23	38.33	38.58	6
	γ Capricorni	21	31	45.20	45.35	7
	Moon I. L.	21	39	47.51		7
	ι Aquarii	21	58	18.70	18.95	7
28	μ Aquarii	20	44	32.85	32.37	7
	η Capricorni	20	55	50.94	50.31	7
	ζ Cygni	21	6	32.87	32.67	7
	20 Piscium	23	40	13.76	13.51	7
	27 Piscium	23	50	59.43	59.43	7
	α Andromedæ	0	0	39.01	38.80	5
	γ Pegasi	0	5	30.93	30.98	7
	Moon I. L.	0	15	23.24		7
	10 Ceti	0	18	55.68	55.76	7
	13 Ceti	0	27	31.33	31.45	7
	δ Piscium	0	40	53.92	54.22	7
	20 Ceti	0	45	20.18	20.56	7
29	δ Piscium	0	40	54.06	54.21	7
	20 Ceti	0	45	20.38	20.56	7
	ε Piscium	0	55	10.12	9.76	7
	Moon I. L.	1	9	37.28		7
	θ′ Ceti	1	16	31.41	31.57	7
	μ Piscium	1	22	19.89	19.71	7
	ν Piscium	1	33	37.81	37.80	7
	ο Piscium	1	37	29.00	28.77	7
Nov. 1	ξ Tauri	3	19	3.02	2.80	7
	e Tauri	3	40	3.19	3.12	7

Date.	Object.	Observed α	Tab. α	No. of Wires.
1849.		h. m. s.	s.	
Nov. 1	λ Tauri	3 52 22.43	22.59	7
	Moon II. L.	4 8 57.99		7
	ε Tauri	4 19 51.72	51.82	7
	α Tauri	4 27 19.08	19.09	7
2	ε Tauri	4 19 52.30	51.83	7
	α Tauri	4 27 19.44	19.11	7
	o′ Orionis	4 44 2.97	3.02	7
	ι Tauri	4 54 7.81	7.92	7
	11 Orionis	4 55 59.69	60.03	5
	β Orionis	5 7 19.49	19.81	7
1849.		h. m. s.		
Nov. 2	Moon II. L.	5 12 37.67	s.	7
5	68 Geminorum	7 25 1.94	1.99	7
	α Canis Min.	7 31 26.06	26.09	7
	β Geminorum	7 36 6.72	6.90	6
	15 Argus	8 1 9.12	8.99	7
	d′ Cancri	8 14 45.18	45.09	7
	Moon II. L.	8 22 54.52		7
	δ Cancri	8 36 8.19	8.13	7
	ε Hydræ	8 38 48.80	48.73	7
	α Cancri	8 50 15.44	15.52	7

Note. — The "Tabular" values are taken in the order of preference, from the Nautical Almanac, the Greenwich Twelve-Year Catalogue, or the British Association's Catalogue.

II. From the "Greenwich Observations" for 1849, we obtain the following corrections of R. A. of the moon's bright limb: —

		s.
July 27	I.	—0.51
28	I.	.55
29	I.	.48
30	I.	.48
31	I.	.26
Aug. 1	I.	.44
3	I.	.18
3	II.	.73
4	II.	.38
6	II.	.38
8	II.	.54
11	II.	.62
		s.
Aug. 23	I.	—1.22
24	I.	.68
29	I.	.46
31	I.	.47
Sept. 5	II.	.22
8	II.	.41
9	II.	.51
		s.
Sept. 22	I.	—0.68
25	I.	.15
26	I.	.22
30	I.	.56
Oct. 2	II.	.67
4	II.	.65
5	II.	.47
8	II.	.32
9	II.	.67
		s.
Oct. 28	I.	—0.60
29	I.	.67
31	II.	.73
Nov. 1	II.	.50
4	II.	.60
5	II.	.74

Longitude of Camp Riley by Corresponding Observations.

	Greenwich — Camp Riley.
	h. m. s.
July 27	7 48 37.98
28	23.51
29	7.45
30	37.60
31	39.29
Aug. 3	31.57
29	39.97
Sept. 5	6.99
	Greenwich — Camp Riley.
	h. m. s.
Sept. 30	7 48 18.27
Oct. 28	24.48
29	15.13
Nov. 1	13.41
5	25.37
Mean,	7 48 24.70

Probable error of result, = ± 2.32

III. The following have been adopted as corrections for the respective lunations: —

		s.
July 27	to August 11	—0.47
August 23	" Sept. 9	—0.54
Sept. 22	" Oct. 9	—0.48
Oct. 28	" Nov. 5	—0.63

Applying these corrections to the computed R. A. of the moon's limb for each date of observation, and comparing with the observed R. A., we obtain,

	h. m. s.
July 27	7 48 36.81
28	20.90
29	6.88
	h. m. s.
July 30	7 48 37.32
31	45.08
Aug. 2	29.28
3	39.60
26	23.07
27	36.91
28	21.77
29	41.89
Sept. 3	9.77
4	18.54
5	15.12
24	41.90

	h. m. s.
Sept. 27	7 48 34.61
28	22.98
29	21.85
30	17.78
Oct. 23	34.80
25	22.50
28	25.02
29	14.09
Nov. 1	16.17
2	18.00
5	22.75
Mean,	7 48 25.98

Probable error of result, = ± 1.44

IV. The result 7h. 48m. 25s.98 is that adopted; transferred to Punta Loma it gives for the longitude of that point 7h. 49m. 0s.48.

This determination places the line of coast farther west than that of the British determination about four minutes of arc, and farther west than the Spanish authorities place it, as much as fifteen minutes of arc.

Application has been made to the Director of the National Observatory and to the Superintendent of the Coast Survey, for the corresponding observations at the Observatories on the Atlantic side of the United States, tributary to the Survey. When received, they will be collated with the above, and the results sent to your Journal.

W. H. EMORY.

Washington, 1851, *June* 11.

OBSERVATIONS OF IRENE,

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By Mr. JAMES FERGUSON.

Communicated by Lieutenant Maury, Director of the Observatory.

[Corrected for refraction.]

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	Irene — Star Δα	Irene — Star Δδ	Irene's apparent α	Irene's apparent δ
1851.	h. m. s.			m. s.	′ ″	h m s.	° ′ ″
June 9	10 39 15.0	8	Weisse XV. 864	—0 35.47	+6 11.00	15 44 22.84	—14 9 41.5
	11 56 23.8	11	" "	—0 37.94	+6 3.62	44 20.40	9 48.8
		11	Weisse XV. 845	+0 41.21	+1 10.52	44 20.95	9 55.5
(1) 10	9 53 20.0	4	" 845	—0 0.98	—1 34.72	43 38.67	12 40.5
	10 24 38.3	2	" 864	—1 20.85	+3 12.68	43 37.53	12 39.8
	10 29 1.6	5	" 845	—0 2.59	—1 40.89	43 37.06	12 46.8
	10 56 50.0	10	" 845	—0 3.30	—1 41.76	43 36.35	12 50.7
13	10 11 13.1	13	Weisse XV. 792	—0 1.42	—0 14.28	41 26.49	22 12.2
	10 58 11.5	10	" "	—0 2.87	—0 20.28	41 25.03	22 18.2
14	10 13 36.9	6	" "	—0 41.65	—3 33.03	40 47.26	25 30.9
	12 18 1.4	10	" "	—0 45.69	—3 51.02	40 43.23	25 48.9
15	11 29 14.6	14	" "	—1 23.85	—7 8.16	15 40 5.07	—14 29 6.0

(1) Measured distance and angle of position.

Adopted Mean Places, 1850.0, *of Comparison-Stars.*

*	Mag.	α	δ
		h. m. s.	° ′ ″
Weisse XV. 864	8	15 44 53.28	—14 15 40.4
" 845	9	15 43 34.64	—14 10 53.7
" 792	9	15 41 22.81	—14 21 45.6

These stars have been determined by Bessel, each from a single observation.

II. *Meridian Observations of Irene, made with the Mural-Circle, Transit, and Meridian-Circle, by Professors* Benedict, Major, *and* Keith.

Date.	α	δ	Date.	α	δ
1851.	h. m. s.	° ′ ″	1851.	h. m. s.	° ′ ″
June 10	15 43 36.95 Mer. Cir.	—14 12 42.02 Mural. 40.36 Mer. Cir.	June 17		—14 35 48.87 Mural.
13		—14 22 8.68 Mural.	18	15 38 18.12 Mer. Cir. .10 Transit.	—14 39 23.07 Mural. 28.51 Mer. Cir.
14	15 40 45.76 Transit.	—14 25 27.07 Mural. 31.00 Mer. Cir.			

EPHEMERIS OF NEPTUNE, FOR 1852.

By SEARS C. WALKER, Esq.

From the "Smithsonian Contributions to Knowledge."

[Reprinted at the request of the author.]

Washington Mean Noon.	♆ α	♆ δ	Washington Mean Noon.	♆ α	♆ δ	Washington Mean Noon.	♆ α	♆ δ
1852.			1852.			1852.		
Jan. 1	339° 3′ 48″.39	—9° 42′ 49″.68	Feb. 22	340° 39′ 43″.08	—9° 4′ 26″.49	April 14	342° 23′ 21″.50	—8° 23′ 41″.45
2	5 10.29	42 16.45	23	41 51.27	3 35.60	15	25 0.08	23 3.33
3	6 33.72	41 42.62	24	43 59.59	2 44.68	16	26 37.44	22 25.74
4	7 58.65	41 8.21	25	46 7.94	1 53.78	17	28 13.54	21 48.68
5	9 25.07	40 33.22	26	48 16.32	1 2.87	18	29 48.37	21 12.14
6	10 52.95	39 57.67	27	50 24.73	9 0 11.96	19	31 21.91	20 36.13
7	12 22.27	39 21.56	28	52 33.17	8 59 21.06	20	32 54.14	20 0.68
8	13 53.00	38 44.90	29	54 41.58	58 30.19	21	34 25.04	19 25.79
9	15 25.13	38 7.70	Mar. 1	56 49.96	57 39.35	22	35 51.56	18 51.47
10	16 58.65	37 29.97	2	340 58 58.26	56 48.55	23	37 22.70	18 17.72
11	18 33.51	36 51.71	3	341 1 6.47	55 57.80	24	38 49.45	17 44.56
12	20 9.69	36 12.94	4	3 14.58	55 7.11	25	40 14.77	17 11.98
13	21 47.19	35 33.66	5	5 22.55	54 16.48	26	41 38.64	16 39.99
14	23 25.97	34 53.88	6	7 30.34	53 25.93	27	43 1.05	16 8.60
15	25 6.02	34 13.61	7	9 37.94	52 35.49	28	44 22.00	15 37.81
16	26 47.33	33 32.86	8	11 45.30	51 45.16	29	45 41.49	15 7.63
17	28 29.86	32 51.64	9	13 52.41	50 54.95	30	46 59.52	14 38.08
18	30 13.58	32 9.96	10	15 59.23	50 4.87	May 1	48 16.10	14 9.15
19	31 58.45	31 27.83	11	18 5.74	49 14.93	2	49 31.22	13 40.85
20	33 44.44	30 45.26	12	20 11.91	48 25.14	3	50 44.80	13 13.19
21	35 31.55	30 2.25	13	22 17.71	47 35.51	4	51 56.82	12 46.17
22	37 19.77	29 18.82	14	24 23.10	46 46.05	5	53 7.22	12 19.80
23	39 9.07	28 34.99	15	26 28.06	45 56.79	6	54 16.00	11 54.09
24	40 59.39	27 50.77	16	28 32.55	45 7.74	7	55 23.18	11 29.03
25	42 50.68	27 6.18	17	30 36.56	44 18.92	8	56 28.77	11 4.64
26	44 42.93	26 21.22	18	32 40.05	43 30.35	9	57 32.74	10 40.92
27	46 36.13	25 35.89	19	34 43.00	42 42.03	10	58 35.07	10 17.87
28	48 30.26	24 50.20	20	36 45.36	41 53.96	11	342 59 35.75	9 55.50
29	50 25.28	24 4.15	21	38 47.13	41 6.14	12	343 0 34.77	9 33.83
30	52 21.17	23 17.75	22	40 48.27	40 18.57	13	1 32.11	9 12.85
31	54 17.89	22 31.05	23	42 48.75	39 31.25	14	2 27.75	8 52.56
Feb. 1	56 15.10	21 44.07	24	44 48.54	38 44.18	15	3 21.67	8 32.98
2	339 58 13.69	20 56.81	25	46 47.62	37 57.36	16	4 13.89	8 14.12
3	340 0 12.75	20 9.27	26	48 45.96	37 10.82	17	5 4.38	7 55.97
4	2 12.53	19 21.45	27	50 43.54	36 24.62	18	5 53.12	7 38.55
5	4 13.02	18 33.35	28	52 40.32	35 38.79	19	6 40.10	7 21.86
6	6 14.21	17 45.02	29	54 36.27	34 53.34	20	7 25.32	7 5.88
7	8 16.08	16 56.46	30	56 31.39	34 8.28	21	8 8.75	6 50.61
8	10 18.62	16 7.68	31	341 58 25.67	33 23.60	22	8 50.39	6 36.06
9	12 21.78	15 18.67	April 1	342 0 9.07	32 39.30	23	9 30.27	6 22.25
10	14 25.51	14 29.44	2	2 11.53	31 55.38	24	10 8.39	6 9.18
11	16 29.77	13 40.02	3	4 3.01	31 11.85	25	10 44.76	5 56.84
12	18 34.55	12 50.42	4	5 53.51	30 28.71	26	11 19.38	5 45.23
13	20 39.82	12 0.64	5	7 43.03	29 45.97	27	11 52.24	5 34.36
14	22 45.54	11 10.70	6	9 31.57	29 3.66	28	12 23.32	5 24.22
15	24 51.67	10 20.62	7	11 19.11	28 21.79	29	12 52.58	5 14.81
16	26 58.18	9 30.40	8	13 5.62	27 40.36	30	13 20.01	5 6.14
17	29 5.02	8 40.04	9	14 51.06	26 59.39	31	13 45.61	4 58.21
18	31 12.15	7 49.54	10	16 35.41	26 18.88	June 1	14 9.38	4 51.03
19	33 19.56	6 58.90	11	18 18.65	25 38.83	2	14 31.32	4 44.60
20	35 27.21	6 8.16	12	20 0.76	24 59.23	3	14 51.45	4 38.92
21	340 37 35.05	—9 5 17.35	13	342 21 41.72	—8 24 20.09	4	343 15 9.77	—8 4 33.99

Washington Mean Noon.	♆ α	♆ δ	Washington Mean Noon.	♆ α	♆ δ	Washington Mean Noon.	♆ α	♆ δ
1852.			1852.			1852.		
June 5	343 15′ 26″.27	—8 4′ 29″.81	Aug. 5	342 38′ 45″.91	—8° 21′ 43″.80	Oct. 5	341 10′ 21″.56	—8° 57′ 59″.74
6	15 40.94	4 26.38	6	37 26.84	22 17.51	6	9 8.25	58 28.60
7	15 53.79	4 23.70	7	36 6.85	22 51.57	7	7 56.07	58 56.98
8	15 4.83	4 21.77	8	34 45.94	23 25.95	8	6 45.07	59 24.87
9	16 14.04	4 20.58	9	33 21.19	24 0.64	9	5 35.26	8 59 52.24
10	16 21.42	4 20.13	10	32 1.64	24 35.63	10	4 26.70	9 0 19.09
11	16 26.97	4 20.43	11	30 38.22	25 10.92	11	3 19.10	0 45.41
12	16 30.68	4 21.48	12	29 14.05	25 46.48	12	2 13.39	1 11.21
13	16 32.56	4 23.28	13	27 49.13	26 22.30	13	1 8.69	1 36.48
14	16 32.62	4 25.83	14	26 23.51	26 58.36	14	341 0 5.34	2 1.15
15	16 30.86	4 29.13	15	24 57.21	27 34.65	15	340 59 3.39	2 25.23
16	16 27.24	4 33.18	16	23 30.29	28 11.17	16	58 2.83	2 48.70
17	16 21.77	4 37.98	17	22 2.76	28 47.89	17	57 3.68	3 11.54
18	16 14.48	4 43.53	18	20 34.67	29 24.79	18	56 6.00	3 33.78
19	16 5.40	4 49.81	19	19 6.06	30 1.86	19	55 9.80	3 55.41
20	15 54.53	4 56.79	20	17 36.95	30 39.08	20	54 15.09	4 16.42
21	15 41.85	5 4.48	21	16 7.37	31 16.46	21	53 21.90	4 36.80
22	15 27.39	5 12.88	22	14 37.38	31 53.97	22	52 30.30	4 56.53
23	15 11.17	5 22.00	23	13 6.98	32 31.59	23	51 40.29	5 15.60
24	14 53.17	5 31.84	24	11 36.23	33 9.33	24	50 51.85	5 34.02
25	14 33.42	5 42.39	25	10 5.15	33 47.16	25	50 5.01	5 51.77
26	14 11.92	5 53.64	26	8 33.78	34 25.07	26	49 19.79	6 8.85
27	13 48.69	6 5.58	27	7 2.17	35 3.03	27	48 36.22	6 25.25
28	13 23.73	6 18.21	28	5 30.34	35 41.03	28	47 54.31	6 40.96
29	12 57.06	6 31.53	29	3 58.32	36 19.04	29	47 14.04	6 55.98
30	12 28.70	6 45.53	30	2 26.14	36 57.06	30	46 35.41	7 10.31
July 1	11 58.65	7 0.21	31	342 0 53.81	37 35.09	31	45 58.44	7 23.94
2	11 26.93	7 15.57	Sept. 1	341 59 21.45	38 13.12	Nov. 1	45 23.20	7 36.86
3	10 53.56	7 31.59	2	57 49.01	38 51.15	2	44 49.72	7 49.05
4	10 18.53	7 48.27	3	56 16.55	39 29.17	3	44 18.00	8 0.52
5	9 41.86	8 5.60	4	54 44.09	40 7.16	4	43 48.05	8 11.26
6	9 3.56	8 23.57	5	53 11.68	40 45.12	5	43 19.89	8 21.27
7	8 23.64	8 42.17	6	51 39.36	41 22.99	6	42 53.54	8 30.54
8	7 42.12	9 1.39	7	50 7.19	42 0.78	7	42 29.05	8 39.06
9	6 59.02	9 21.21	8	48 35.17	42 38.46	8	42 6.42	8 46.83
10	6 14.32	9 41.69	9	47 3.33	43 16.03	9	41 45.64	8 53.85
11	5 28.05	10 2.74	10	45 31.73	43 53.46	10	41 26.73	9 0.12
12	4 40.25	10 24.38	11	44 0.38	44 30.73	11	41 9.70	9 5.62
13	3 50.93	10 46.60	12	42 29.32	45 7.81	12	40 54.55	9 10.35
14	3 0.10	11 9.39	13	40 58.61	45 44.68	13	40 41.29	9 14.32
15	2 7.78	11 32.74	14	39 28.27	46 21.36	14	40 29.93	9 17.52
16	1 13.98	11 56.64	15	37 58.35	46 57.83	15	40 20.50	9 19.93
17	343 0 18.73	12 21.07	16	36 28.89	47 34.06	16	40 13.00	9 21.57
18	342 59 22.07	12 46.15	17	34 59.91	48 10.06	17	40 7.42	9 22.43
19	58 24.00	13 12.77	18	33 31.46	48 45.79	18	40 3.76	9 22.51
20	57 24.53	13 38.94	19	32 3.58	49 21.20	19	40 2.05	9 21.82
21	56 23.70	14 5.65	20	30 36.32	49 56.39	20	40 2.28	9 20.34
22	55 21.55	14 32.87	21	29 9.69	50 31.10	21	40 4.45	9 18.09
23	54 18.09	15 0.61	22	27 43.71	51 5.59	22	40 8.55	9 15.05
24	53 13.35	15 28.86	23	26 18.45	51 39.75	23	40 14.60	9 11.24
25	52 7.37	15 57.59	24	24 53.94	52 13.57	24	40 22.59	9 6.65
26	51 0.15	16 27.80	25	23 30.19	52 47.03	25	40 32.53	9 1.28
27	49 51.74	16 57.48	26	22 7.24	53 20.13	26	40 44.40	8 55.13
28	48 42.14	17 27.62	27	20 45.11	53 52.86	27	40 58.22	8 48.20
29	47 31.40	17 58.21	28	19 23.83	54 25.19	28	41 13.98	8 40.48
30	46 19.51	18 29.21	29	18 3.44	54 57.11	29	41 31.68	8 31.98
31	45 6.53	19 0.69	30	16 43.98	55 28.62	30	41 51.32	8 22.71
Aug. 1	43 52.46	19 32.55	Oct. 1	15 25.46	55 59.72	Dec. 1	42 12.91	8 12.67
2	42 37.35	20 4.81	2	14 7.93	56 30.39	2	42 36.45	8 1.85
3	41 21.18	20 37.41	3	12 51.41	57 0.62	3	43 1.92	7 50.25
4	342 40 4.01	—8 21 10.44	4	341 11 35.95	—8 57 30.41	4	340 43 29.32	—9 7 37.88

Washington Mean Noon.	♆ α	♆ δ	Washington Mean Noon.	♆ α	♆ δ	Washington Mean Noon.	♆ α	♆ δ
1852.	° ′ ″	° ′ ″	1852.	° ′ ″	° ′ ″	1852.	° ′ ″	° ′ ″
Dec. 5	340 43 58.66	—9 7 24.74	Dec. 15	340 50 37.13	—9 4 31.49	Dec. 25	341 0 19.59	—9 0 25.32
6	44 29.92	7 10.83	16	51 27.27	4 10.05	26	1 27.41	8 59 56.95
7	45 3.08	6 56.15	17	52 19.26	3 47.90	27	2 36.91	59 27.92
8	45 38.16	6 40.70	18	53 13.10	3 25.03	28	3 48.06	58 58.23
9	46 15.21	6 24.50	19	54 8.77	3 1.44	29	5 0.86	58 27.89
10	46 54.16	6 7.55	20	55 6.23	2 37.14	30	6 15.29	57 56.91
11	47 35.01	5 49.85	21	56 5.44	2 12.14	31	7 31.32	57 25.29
12	48 17.75	5 31.39	22	57 6.38	1 46.45	32	8 48.94	56 53.03
13	49 2.36	5 12.17	23	58 9.06	1 20.07	33	341 10 8.15	—8 56 20.14
14	340 49 48.82	—9 4 52.20	24	340 59 13.46	—9 0 53.02			

COÖRDINATES.

(x, y, *and* z *are referred to the Apparent Equinox and Equator.*)

Date 1852.	x	y	z	Log. △	Date 1852.	x	y	z	Log. △
Jan. 7	+27.89188	—9.83185	—4.751536	1.4852396	July 17	+28.10376	—9.30231	—4.539517	1.4659296
15	.90094	.80989	.742538	.4866768	25	.11236	.28014	.530644	.4645896
23	.90997	.78793	.733741	.4879150	Aug. 2	.12093	.25796	.521768	.4634626
31	.91898	.76589	.724937	.4889322	10	.12947	.23578	.512890	.4625736
Feb. 8	.92798	.74384	.716152	.4897129	18	.13798	.21361	.504010	.4619424
16	.93696	.72182	.707360	.4902456	26	.14647	.19144	.495127	.4615851
24	.94591	.69982	.698566	.4905268	Sept. 3	.15494	.16928	.486242	.4615088
Mar. 3	.95483	.67782	.689770	.4905509	11	.16339	.14712	.477355	.4617170
11	.96372	.65583	.680977	.4903032	19	.17182	.12495	.468467	.4622045
19	.97259	.63383	.672185	.4898097	27	.18022	.10278	.459576	.4629647
27	.98145	.61182	.663386	.4890803	Oct 5	.18860	.08060	.450681	.4639844
April 4	.99030	.58981	.654584	.4881179	13	.19697	.05841	.441784	.4652535
12	27.99913	.56781	.645772	.4869426	21	.20532	.03621	.432884	.4667244
20	28.00794	.54576	.636949	.4855743	29	.21366	9.01399	.423980	.4683751
28	.01674	.52371	.628119	.4840339	Nov. 6	.22198	8.99174	.415069	.4701721
May 6	.02551	.50164	.619278	.4823511	14	.23029	.96949	.406142	.4720793
14	.03430	.47955	.610329	.4805521	22	.23858	.94721	.397214	.4740572
22	.04304	.45744	.601574	.4786651	30	.24685	.92492	.388280	.4760645
30	.05176	.43531	.592712	.4767258	Dec. 8	.25511	.90261	.379337	.4780658
June 7	.06048	.41317	.583849	.4747662	16	.26335	.88029	.370388	.4800201
15	.06918	.39101	.574987	.4728306	24	.27157	.85796	.361432	.4818899
13	.07785	.36884	.566123	.4709446	32	.27977	.83563	.352470	.4836414
July 1	.08650	.34666	.557257	.4691375	40	+28.28795	—8.81329	—4.343506	1.4852454
9	+28.09514	—9.32449	—4.548388	1.4674568					

ELEMENTS AND EPHEMERIS OF IRENE.

By Mr. JAMES FERGUSON.

[Communicated by Lieutenant Maury.]

Irene, 1851, June 10.0, Mean Equinox, M. T. Greenwich.

M	41° 57′ 9″.5
☊	87 47 46.2
π	191 8 27.5
i	8 37 35.7
φ	8 40 50.5
a	0.4069322
μ	870″.18

Approximate Ephemeris for Mean Noon Greenwich.

	α	δ	Log △
	h. m. s.	° ′ ″	
June 27	15 34 53	—15 18 40	0.16040
July 1	33 59	35 58	.17161
5	33 36	54 21	.18368
9	33 33	16 14 3	.19430
13	33 58	35 16	.20690
17	15 31 51	—16 56 55	0.21910

	α	δ	Log △		α	δ	
	h. m. s.	° ′ ″			h. m. s.	° ′ ″	
July 21	15 36 10	—17 19 22	0.23122	July 29	15 40 7	—18 5 18	0.25694
25	15 37 58	—17 42 15	0.24359	Aug. 2	15 42 43	—18 28 21	0.26843

WASHINGTON OBSERVATIONS FOR 1846.

The United States Naval Observatory at Washington, under the superintendence of Lieutenant Maury, has recently published its observations for the year 1846, in an elegant quarto volume, the second of the series under the present organization of the Observatory. The Superintendent's time being mostly consumed in attending to the official business connected with his station, the astronomers in charge of the several instruments have prepared the preliminary remarks and explanations of the printed observations, each for his own instrument; viz. Professor Keith for the Transit-Instrument, Professor Coffin for the Mural-Circle, and Professor Hubbard for the Meridian-Circle and Prime-Vertical Transit-Instrument.

Among the observations with the equatorial are determinations of the places of several comets, and of *Neptune*, — measurements of distances of the cusps during the solar eclipse of April 24 – 25, and a number of transits of both limbs of the sun and moon. The catalogue of fixed stars contains 595 which were observed during the year.

In an Appendix of 161 pages, Lieutenant Maury has given a series of letters on various subjects, — mostly relating to the claims of Dr. Locke to the discovery of the telegraphic system of recording observations, and to the wind and current charts prepared and published under his superintendence at the Observatory.

G.

Continued ill-health having made it imperative upon the Editor to absent himself from his post for a while, his friends Professor Peirce of Cambridge and Professor Hubbard of Washington have kindly consented to conduct the *Astronomical Journal* during his absence. All communications for insertion in the Journal will therefore be directed to one of these gentlemen. All letters relating to the financial affairs of the Journal may be directed to the Editor, as before.

Cambridge, 1851, *July* 14.

CORRIGENDA.

Page 27, line 5, *for* Δd^2, *read* $\frac{1}{2}\Delta d^2$.
" " " 7, " ditto, " ditto.
" " " —1, " a, " α.

CONTENTS.

Determination of the Longitude of Camp Riley, near the Initial Point of the Boundary Line between the United States and Mexico on the Pacific Coast, by Major W. H. Emory.
Observations of Irene, made with the Filar-Micrometer of the Washington Equatorial, by Mr. James Ferguson.
Ephemeris of Neptune, for 1852, by Sears C. Walker, Esq.
Elements and Ephemeris of Irene, by Mr. James Ferguson.
Washington Observations for 1846.
Corrigenda.

CAMBRIDGE: METCALF AND COMPANY, PRINTERS TO THE UNIVERSITY.

THE

ASTRONOMICAL JOURNAL.

No. 30.

VOL. II. CAMBRIDGE, 1851, OCTOBER 3. NO. 6.

THE FIRST COMET OF 1851.

A TELESCOPIC comet was discovered by Dr. D'ARREST at Leipsic, on the 29th of June. It has since been observed also at Altona and Berlin, and later at Washington. Observations and elements will be found below.

H.

FROM A LETTER OF DR. PETERSEN, OF ALTONA, TO THE EDITOR.

Altona, 1851, *July* 11.

As the new comet is very faint, although it may yet be observed for some time with powerful telescopes, I hasten to send you some details respecting it.

I have received from D'ARREST the following observations:—

1851.	M. T. Leipsic. h. m. s.	☄'s app. α	☄'s app. δ
June 29	13 4 5	10° 4′ 47″	+10° 37′ 35″
30	13 13 19	11 12 8	10 40 46
July 1	12 35 43	12 16 35	10 40 36 Decl.?
1	12 58 53	12 17 43	——
2	13 4 20	13 24 12	10 45 7
4	12 53 25	15 34 6	10 48 15
6	13 2 57	17 44 36	+10 49 26

The apparent place of the star of comparison, July 1, assumed according to BESSEL:

$$\alpha = 12^\circ 21' 18''.7 \qquad \delta = +10^\circ 35' 58''.2$$

is probably about 3′ in error in declination. Dr. D'ARREST has computed from the observations of June 29, July 2, and 6, the following elements, which he considers as quite approximate.

T	1851, July 6.35816 M. T. Berlin.	
π	324° 35′ 59″.8	App. Equinox.
☊	152 41 33.2	
i	14 43 38.8	
Log q	0.0892774	
	Direct.	

He remarks here the similarity of these elements with those of the comet of 1678, excepting, perhaps, the inclination, but he attaches less weight to this resemblance, since already LE VERRIER and BRUNNOW have recognized in the comet of 1678 a previous appearance of DE VICO's.

D'ARREST has also computed from his elements the following places to give an idea of the comet's path: —

M. T. Berlin.	α	δ	Log r	Log △	Brilliancy.
1851, July 6.5	17° 45′	+10° 49′	0.089	9.907	1.03
16.5	27 49	10 31	.093	.913	0.97
26.5	36 42	9 39	.103	.922	.89
Aug. 5.5	41 13	8 20	.118	.934	.79
15.5	50 21	6 41	.138	.946	.68
25.5	55 2	+4 47	0.161	9.957	0.58

I have also received from Messrs. E. VOGEL and G. RÜMKER, in Berlin, the following elements, which they have computed from the observation at Leipsic, June 29, the mean of those at Leipsic and Berlin, July 2, and at Berlin, July 5.

The middle place is represented by these elements thus:

$$\overset{\text{C. – O.}}{d\lambda = +7'' \qquad d\beta = 0}$$

T	1851, July 6.14735 M. T. Berlin.	
π	324° 19′ 44″	App. Equinox.
☊	152 40 44	
i	14 39 36	
Log q	0.089026	
	Direct.	

OBSERVATIONS MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By Mr. JAMES FERGUSON.

Communicated by Lieutenant Maury, Director of the Observatory.

[Corrected for refraction.]

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	☄ — *		☄'s apparent		A.
				$\Delta\alpha$	$\Delta\delta$	α	δ	
1851	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″	
August 6	14 3 20.3	13	Weisse III. 62	+0 42.75	+6 27.00	3 5 19.06	+8 8 18.20	
13	13 59 15.9	6	" 428	+0 19.837	−6 29.27	3 24 27.13	+6 56 49.89	9

Adopted Mean Places, 1850.0, *of Comparison-Stars.*

	Mag.	α	δ
		h. m. s.	° ′ ″
Weisse III. 62		3 4 33.00	+8 1 32.60
" 428	8	3 24 3.01	+7 3 1.58

The comet is very faint; about three minutes of arc in diameter. It bears scarce any illumination.

OBSERVATIONS MADE AT THE HARVARD OBSERVATORY, CAMBRIDGE.

1851.	M. S. Time.	R.A.	Decl.	
	h. m. s.	h. m. s.	° ′ ″	
Aug. 31	16 14 13.60	4 1 52.29	+3 21 8.08	Mean Equinox of Jan. 1, 1851.
Sept. 3	15 42 39.99	4 6 8.77	+2 37 42.57	
5	15 54 1.05	4 8 50.77	+2 10 41.10	

THE SECOND COMET OF 1851.

The following circular has been received from Dr. Petersen, announcing the discovery of another comet. It has been observed at Washington, as below.

H.

Altona, 1851, *August* 5.

Mr. Brorsen has discovered, at the Senftenberg Observatory, on the 1st of August, about 11h. 45m. P. M., in the constellation of the Hunting Dogs, a telescopic comet, which he speaks of as small, but quite bright. From seven comparisons with Bessel's star, 8th mag., Z. 413, $\alpha = 13^{h.}\ 53^{m.}\ 57^{s.}.12$, $\delta = +31°\ 31'\ 40''.2$, there results: —

1851.	M. Senft. Time.	☄'s R A.	☄'s Decl.
	h. m. s.	h. m. s.	° ′ ″
August 1	13 9 21.4	13 54 58.43	+31 27 7.3
Daily motion		+ 1 32.9	+ 23 25.0

The low position of the comet and fleeting clouds rendered the observations very difficult.

At the Altona Observatory, I found its apparent position yesterday evening.

	M. Altona T.	☄'s R.A.	☄'s Decl.
	h. m. s.	h. m. s.	° ′ ″
August 4	11 25 53	13 59 58.93	+32 48 2.6

But the air was so unquiet and bad, that I could only see the comet with great difficulty, and hence these observations, especially in declination, deserve but little confidence.

Mr. Rümker has observed at the Hamburg Observatory: —

	M. Hamburg T.	☄'s app. R.A.	☄'s app. Decl.
	h. m. s.	h. m. s.	° ′ ″
August 4	11 16 12	13 59 58.56	+32 48 20.3

A. C. PETERSEN.

OBSERVATIONS MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By Mr. JAMES FERGUSON.

[Communicated by Lieutenant Maury.]

[Corrected for refraction.]

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	☄ — ✱		☄'s apparent	
				Δα	Δδ	α	δ
1851.	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″
August 26	10 44 55.6	4	Groom. 2168	—0 27.10	—1 20.17	14 50 02.72	+43 26 41.01
27	9 16 14.0	6	B. Z. 473	+0 10.65	—5 44.91	14 52 48.70	43 55 6.03
		6	" "	—0 53.20	—1 6.35	14 52 48.50	43 55 7.92

Adopted Mean Places, 1850.0, of Comparison-Stars.

	α	δ
	h. m. s.	° ′ ″
Gr. 2168 from Radcliffe Observations	14 50 27.50	+43 28 01.04
Bessel's Zone 473	14 52 35.82	44 0 50.63
"	14 53 39.42	43 56 13.89

The comet is very faint, bearing scarce any illumination.

OBSERVATIONS MADE AT THE HARVARD OBSERVATORY, CAMBRIDGE.

	M. S. Time.	R.A.	Decl.
	h. m. s.	h. m. s.	° ′ ″
August 21	8 49 50.24	14 36 8.76	+40 53 44.80
23	9 2 59.07	14 41 25.26	+41 53 47.01
26	8 58 42.52	14 49 47.14	+43 23 35.33
August 28	8 39 33.79	14 55 44.97	+44 24 25.59
29	8 25 23.32	14 58 48.47	+44 54 37.59

Mean Equinox of Jan. 1, 1851.

OBSERVATIONS OF METIS AND PARTHENOPE.

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By Mr. JAMES FERGUSON.

Communicated by Lieutenant Maury.

[Corrected for refraction and parallax.*]

METIS.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	⊛ — ✱		⊛'s apparent		A.
				Δα	Δδ	α	δ	
1851.	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″	
Jan. 13	15 8 3.1	4	Bessel's Zone 275 (*a*)	—2 16.11	+13 26.98	9 58 50.02	+21 16 52.35	10
	16 4 3.9	7	"	—2 17.88	+13 38.53	9 58 48.25	21 17 3.90	10
15	16 57 33.5	8	*a*	—0 10.16	+13 19.83	9 57 36.30	21 30 51.93	10
Feb. 22	10 14 35.6	8	Bessel's Zone 345 (*a*)	—0 31.73	+ 9 28.49	9 22 24.95	25 13 15.77	10
March 1	9 37 5.0	8	B. A. C. 3194	+1 42.87	—20 28.51	9 16 37.75	25 28 58.85	10
	10 27 2.4	2	"	+1 41.42	—20 21.02	9 16 36.35	25 29 6.34	10
2	9 8 38.5	10	"	+0 59.97	—19 25.70	9 15 54.85	25 30 1.67	10
21	10 26 33.1	10	Bessel's Zone 347	—0 7.45	+ 0 14.88	9 7 59.18	25 15 38.30	8
24	9 23 51.3	4	"	—0 17.38	— 7 47.47	9 7 49.17	+25 7 36.25	10

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* The corrections for refraction and parallax are applied to Δα and Δδ.

Date.	M. T. Washington.	No of Comp.	Comparison-Star.	⚶ — ∗ Δα	⚶ — ∗ Δδ	⚶'s apparent α	⚶'s apparent δ	A.
1851.	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″	
April 3	9 30 06.4	4	Bessel's Zone 345 (*b*)	+0 34.34	+14 15.72	9 9 18.20	+24 31 12.99	9
6	9 15 47.8	14	" 345 (*b*)	+1 36.16	+ 1 20.79	9 10 19.96	24 17 48.50	10
11	10 14 27.9	3	" 345 (*b*)	+3 53.32	—23 25.71	9 12 37.01	23 53 2.20	8
18	10 26 45.4	9	" 345 (*c*)	—0 45.51	— 2 55.81	9 16 51.53	23 14 7.77	10
		9	" 345 (*d*)	—0 57.26	— 2 53.26	9 16 51.39	23 14 4.13	10
21	8 55 44.6	10	" 345 (*c*)	+1 21.14	—20 32.65	9 18 57.85	22 36 31.15	8
		10	" 345 (*d*)	+1 9.61	—20 31.67	9 18 58.32	22 36 26.94	8
29	9 48 49.3	8	" 278 (*a*)	+3 4.46	+ 7 55.17	9 25 38.38	22 4 26.06	8
May 1	9 56 27.3	4	" 278 (*b*)	—2 45.95	+ 1 24.23	9 27 28.96	21 50 40.86	8
		4	" 278 (*c*)	—3 19.84	— 1 22.58	9 27 29.49	21 50 39.02	8
2	9 40 5.5	6	" 278 (*b*)	—1 49.39	— 5 16.10	9 28 24.99	21 44 0.68	10
		6	" 278 (*c*)	—2 23.67	— 7 59.80	9 28 25.70	21 44 1.82	10
6	10 12 5.6	10	" 278 (*d*)	+1 36.69	+ 6 57.13	9 32 23.96	21 14 48.88	9
7	8 19 59.6	4	" 278 (*d*)	+2 33.48	+ 0 11.00	9 33 20.83	21 8 2.71	9
11	8 21 49.0	8	B. A. C. 3318	+2 34.65	—14 21.81	9 37 36.11	20 37 54.56	8
21	8 44 37.0	7	Rümker 3002	+1 47.14	—13 39.99	9 49 6.71	19 17 50.78	10
	9 32 52.7	4	"	+1 50.28	—14 02.91	9 49 7.57	19 17 27.86	10
24	8 25 31.4	7	Bessel's Zone 275 (*c*)	+1 34.54	+ 3 33.90	9 52 45.37	18 52 37.58	7
26	8 29 57.1	9	" 274	—1 42.15	+18 7.06	9 55 15.24	18 35 28.24	10
June 4	8 37 45.2	6	" 401	+2 1.41	— 0 36.09	10 6 55.37	+17 15 35.69	8

Adopted Mean Places, 1850.0, *of Comparison-Stars.*

∗	Mag.	α	δ	Authority.	No. of Comp.
		h. m. s.	° ′ ″		
Bessel's Zone 275 (*a*)	6	10 1 2.57	+21 3 49.19	Bessel's Zones.	
a	9.10	9 57 42.82	21 17 55.98	W. Equatorial from B. Z. 275.	5
Bessel's Zone 345 (*a*)	9	9 22 52.40	25 4 8.95	Bessel's Zones.	
B. A. C. 3145	6.7	9 11 50.51	25 49 17.70	British Association Catalogue.	
Bessel's Zone 347	8.9	9 8 2.43	25 15 41.87	Bessel's Zones.	
Bessel's Zone 345 (*b*) (1)	8.9	9 8 39.64	24 16 44.81	"	
" 345 (*c*)	9	9 17 33.05	23 17 20.74	"	
" 345 (*d*)	9	9 17 45.04	23 17 15.56	"	
" 278 (*a*)	9	9 22 29.98	21 56 47.82	"	
" 278 (*b*)	9	9 30 11.34	21 49 34.67	"	
" 278 (*c*)	9	9 30 45.72	21 52 19.65	"	
" 278 (*d*)	9	9 30 43.91	21 8 8.91	"	
B. A. C. 3318	7	9 34 58.07	20 52 33.60	Rümker's Catalogue.	
Rümker 3002	8.9	9 47 16.00	19 31 48.26	"	
Bessel's Zone 275 (*c*)	9	9 51 7.55	18 49 21.50	Bessel's Zones.	
" 274	9	9 56 54.11	18 17 39.15	"	
" 410	9	10 4 50.76	+17 16 29.85	"	

(1) 345 (*b*) is double. It is 1332 of STRUVE.

The following comparisons of *Metis* have been made, as part of a series of observations intended for determining the relative brightness of the Asteroids. *Astræa*, *Iris*, *Flora*, and *Clio* have already been compared, and the same method will be applied to the others, should the results be satisfactory. It is proposed to make these comparisons near the opposition, as well as at the greatest distances. The stars compared with are usually double-stars of the greatest distance; it being supposed that these will be more constantly and frequently observed, and have their magnitudes more accurately estimated. The selected stars are such as have components of nearly the same magnitude, so that contrast may have less influence upon the estimation. They are taken as near as possible to the place of the Asteroid, to avoid the effect of partial difference of atmosphere, and the comparisons have always been made under the same circumstances of illumination. BESSEL and STRUVE are taken as authorities for magnitude, though the estimate of STRUVE is in almost every instance one grade higher than that of BESSEL.

An estimate has also been made of the magnitude of the comparison-star at the time of observation. For this comparison BESSEL's 9th magnitude has been taken as a standard, both because it is more frequently found in the Zones, and has there a very certain value, and also on account of the direct reference which he himself has made of it to the *Pleiades*.[*]

The lesser magnitudes, particularly the 10th and 11th, are not susceptible of such perfect definition, Bessel scarce ever giving as low as the 10th, and other observers differing much in their estimates. As a guide it has been assumed that the 13th magnitude is the lowest visible with any illumination in the Washington Equatorial, and the interval between that and the 9th has as nearly as possible been divided and referred to stars of which a list will be given hereafter.

From the 6th to the 11th will include all the magnitudes necessary in these comparisons, and by referring them to particular stars as a representative of each grade, the results will become independent of the estimate of any particular observer.

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[*] "I put all stars as of the 9th magnitude which, with sufficient illumination, do not, on moving the telescope, pass easily unobserved through the field. Stars of the 9.10th magnitude are more difficult to find; while for the 10th magnitude in my telescope of four inches aperture, the illumination must be too faint to make the wires visible. What stars I designate as of particular magnitudes will be better known from the following notice. But in future I mean to carry out the counsel of my honored friend Tralles, and designate in some particular part of the heavens (perhaps the *Pleiades*) a number of stars to which the different magnitudes may be referred." — Bessel, in *Astronomische Nachrichten*, Bd. I. No. 17.

Comparisons of Metis for Magnitude, made with the Washington Equatorial.

Date of Observation.	Estimated Magnitudes of Stars of Comparison.				Magnitude estimated at Observation.	Mag. of Metis.	Log. △
	Bessel.		Struve.				
	Designation.	Magnitude.	Designation.	Magnitude.			
1851.							
Feb. 22	Zone 345	9				9.1	0.1191
Mar. 21	" 347	8.9					
(1)	Weisse VII. 525	9	1087 Mens. Microm.	(8.2) (11.5)	(9) (12.5)	9	.1842
	Weisse VII. 531, 532	(9.10) (8.9)	1088 Mens. Microm.	(9) (7)	(10.5) (8)		
24	Zone 347	9				9	.1930
(2) 26			1452 Mens. Microm.	(9) (9 1)	(9.4) (9.5)	9	.1990
(3) April 3	Zone 345	(8.9) (9)	1332 Mens. Microm.	(7.2) (7.5)		9.6	.2233
(4) 6	Same stars as 3d.				(8.4) (8.7)	9.7	.2324
11	Same stars as 3d.					9.4	.2485
18	Zone 345 (*b*), (*c*), (*d*)	9				9.4	.2687
21	Same stars as 18th.					9.4	.2779
(5) 29	Zone 278	9				10.2	.3019
May 1	Zone 278; two stars.	(9) (9)				9.8	.3081
(6) 2			1285 Mens. Microm.	(9) (9.7)	(9.4) (9 6)	9.7	.3109
6	Zone 278	9				9.7	.3209
24	Zone 278	9				9.2	.3676
26			1395 Mens. Microm.	(8) (10.5)	(8.6) (10.5)	9.5	0.3728

(1) The largest star, 525, only observed by Bessel. The planet of the same apparent magnitude as 525.

(2) According to Struve, *Metis* would be 8.6.

(3) According to Struve, *Metis* would be 8.1.

(4) Night very clear and serene.

(5) Bad night.

(6) *Metis* same as lesser star.

PARTHENOPE.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	⚲ — *		⚲'s apparent		A.
				Δ α	Δ δ	α	δ	
1851.	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″	
August 6	13 9 7.6	1	Weisse II. 81	+0 27.43	+10 28.81	2 6 46.87	+7 30 52.91	10
13	12 53 34.1	8	" 158	+1 15.12	+ 9 7.22	2 12 5.36	7 38 38.51	9
16	12 26 5.9	5	" 235	−1 3.75	−12 10.12	2 13 59.92	7 39 45.57	10
	12 50 50.1	8	" 235	−1 2.87	−12 9.25	2 14 0.50	7 39 46.44	10

Adopted Mean Places, 1850.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
		h. m. s.	° ′ ″	
Weisse II. 81	9	2 6 15.06	+7 20 0.58	Weisse's Catalogue.
" 158	7	2 10 45.67	+7 29 7.25	" "
" 235	8	2 14 59.08	+7 51 31.59	" "

OBSERVATIONS OF IRENE AT THE ALTONA OBSERVATORY.

I. *Ring-micrometer Observations.*

1851.	M. T. Altona.	α	Log $\frac{p}{P}$	δ	Log $\frac{q}{P}$	Comp.	
	h. m. s.						
May 24	10 10 40.4	239° 49′ 29″.9	9.4166	—13° 31′ 23″.6	9.9580	5	
	10 39 18.8	49 6.0	9.2778	31 24.6	9.9611	5	
	11 43 54.8	48 26.0	8.2996	31 31.8	9.9642	6	
26	11 20 7.1	18 50.5	8.7577	35 11.1	9.9641	8	
27	10 59 59.6	239 4 16.4	8.9982	37 7.1	9.9636	8	
28	10 34 25.6	238 49 50.0	9.1812	39 6.0	9.9626	8	
31	10 42 35.3	238 6 34.5	8.9645	45 35.9	9.9643	6	
June 1	10 32 12.2	237 52 38.0	9.0283	47 49.1	9.9641	6	Misty.
4	10 43 50.7	237 11 27.4	8.5726	—13 55 14.8	9.9654	8	

If P denote the horizontal parallax of the planet, then for the respective observations the parallax in $\alpha = p$, and in $\delta = q$.

The apparent places of the stars of comparison are assumed, according to observations with the Hamburg meridian-circle and our own, as follows: —

	h. m. s.	° ′ ″
May 24	15 59 53.63	—13° 32′ 2″.8
May 26	15 59 53.64	—13° 32′ 2″.8
27	58 46.76	40 0.4
28	58 46.77	40 0.4
31	49 52.72	50 43.7
June 1	49 52.73	50 43.7
4	15 47 55.08	—13 57 25.1

II. *Observations with the Meridian-circle.*

1851.	M. T. Altona.	App. α	App. δ
	h. m. s.		
May 24	11 51 24	239° 48′ 25″.5	—13° 31′ 30″.8
27	11 36 41	239 3 48.9	37 7.6
28	11 31 46	238 49 12.4	39 8.3
31	11 17 7	238 6 5.7	45 39.4
June 1	11 12 15	237 52 4.6	—13 47 57.0

The ring-micrometer observations were made by myself with the small Fraunhofer of 34 lines aperture, and 42 inches focal distance, with a magnifying power of 45: the observations with the meridian-circle are by Mr. Sonntag.

A. C. PETERSEN.

ON THE ORBIT OF THE GREAT COMET OF 1843.

By PROFESSOR J. S. HUBBARD.

(*Continued from* Vol. I. p. 154.)

§ 7.

At this point of the investigation, I received from Admiral Beaufort a copy of a letter from Mr. Maclear to the Secretary of the Royal Astronomical Society, containing the complete series of observations made at the Cape of Good Hope, and a catalogue of the mean places for 1843.0 of the stars of comparison as determined at the Cape Observatory. As the original letter is intended for publication by the Astronomical Society, it will only be necessary to quote here the resulting places of the comet, and one or two of the observer's remarks.

In the previous communication, the clock-error had been given without its sign, and the present letter enabled me to ascertain that I had assumed the wrong one, thus vitiating the results given above (Vol. I. p. 153). I have been enabled now also to reduce another observation of distance, on the 6th of March. In the following, which is the complete list of the Cape observations, the observed distances have been corrected only for index-error, the refraction and parallax having been applied to the computed values; the right-ascensions and declinations have been reduced in the usual manner. The (C. — O.) are the result of comparison with Elements V.

M. T. Berlin.	Star.	Observed Distance.	C. — O.	No. Obs.
Mar. 4.29727	Sirius	91° 14′ 15″.7	—27″.1	15
5.29159	Sirius	90 41 55.7	—48.8	6
5.30523	α Tauri	67 2 6.0	—57.5	5
6.29779	Sirius	87 11 16.0	—50.2	5

M. T. Berlin.	α	C. — O.	No. Obs.	M. T. Berlin.	δ	C. — O.	No. Obs.
March 5.28155	5° 5′ 28″.9	+11″.0	2	.28688	—12° 1′ 13″.2	+ 4″.1	3
6.28589	8 49 48.1	(—71.5)(1)	3	.28589	12 7 5.9	— 3.9	3
8.30760	15 51 25.8	—16.8	7	.31266	12 5 48.8	+ 4.6	3
9.30513	19 6 17.2	— 6.7	24	.30804	11 59 42.4	+ 3.4	14
10.30154	22 12 12.7	—17.7	18	.30531	11 50 23.1	—22.8	13
11.33687	25 15 50.1	—29.4	8	.33687	11 40 28.2	(+77.7)(2)	3
13.31715	30 39 41.4	— 3.5	24	.32191	11 11 40.3	— 7.0	16
14.30440	33 8 52.4	— 4.8	24	.30948	10 56 19.6	— 4.7	16
16.33644	37 51 23.2	+ 2.8	8	.33898	10 22 34.7	— 4 5	4
16.35192	37 54 4.8	—36.8	12	.35443	10 22 16.2	— 7.2	8
18.32176	41 58 47.8	—11.4	36	.32398	9 48 16.6	— 3.5	12
19.34612	43 56 1.8	+ 0.2	16	.35146	9 30 29.1	— 0.7	8
22.31060	49 1 58.8	— 0.1	36	.31367	8 40 0.0	— 3.1	24
25.30383	53 27 18.8	+ 7.4	36	.30750	7 51 55.1	+ 2.4	24
31.32343	60 41 53.5	— 1.5	48	.32755	6 26 26.5	+ 2.3	32
April 2.30655	62 42 50.8	— 9.7	48	.30999	6 1 49.9	+ 7.8	32
3.30623	63 40 15.0	— 2.2	48	.31014	5 50 2.4	+10.6	32
5.31323	65 29 51.6	—15.1	60	.31687	5 27 31.2	+11.8	40
7.29417	67 10 27.4	— 2.1	24	.29784	5 6 48.5	+12.7	16
8.27905	67 58 19.7	— 9.8	18	.28349	4 57 2.3	+13.1	12
9.27673	68 45 7.3	— 4.4	18	.28143	4 47 47.6	+31.2	12
18.30314	74 55 12.4	—42.1	36	.30714	3 35 20.0	+ 7.8	24
19.29026	75 30 15.9	—11.5	24	.29425	—3 29 3.0	+20.2	16

(1) "The star observed was a very inconvenient one, but the first which appeared in the twilight; the eye-piece of the micrometer had to be moved to see first the comet and then the star; the distance between them being so great ($\Delta\delta = 39'$). The shakiness of the instrument renders such a proceeding very dangerous."

(2) "Caught a glimpse of the comet just before setting, but the mist between was so thick, that the comet was barely visible; a large star was near it, but the definition was so bad that the star was as nebulous a looking body as the comet."

I have also recently received from Professor Bartlett the following observations made by himself at West Point, partly with the filar-micrometer, and partly with the circles of the equatorial.

M. T. Berlin.	α	C. — O.	δ	C. — O.
March 24.56484	52° 25′ 39″.5	—11″.5	—8° 2′ 52″.3	—38″.0
25.56638	53 48 12.7	+43.2	7 47 43.2	— 9.6
26.56209	55 8 59.3	—53.3	7 33 0.8	+15.0
29.57138	58 46 19.1	+32.6	6 49 58.3	+16.4
April 2.56831	62 58 24.2	—26.9	—5 58 32.9	— 3.4

The list of stars of comparison furnished by Mr. Maclear has enabled me to make a few additional corrections to the assumed places as given by the observer. For instance, the star Weisse IV. 702, for which the mean of Bessel's and Lalande's positions was assumed by Mr. Walker, is found to have a sensible proper motion requiring a correction of +11″.7 to the observed R.A. of the comet.

With the new residuals, I obtained another system of elements, which represented the whole series of observations more closely than Elements V., and computed again the probable errors, adopting a somewhat different classification. The Trevandrum series had previously been ranked with the filar-micrometer observations, rather on account of its importance in point of time than from its intrinsic excellence. It properly belongs to the class of instrumental positions, of which the Kremsmünster series is another example. As the two occur, however, in different epochs, I computed the probable error of each independently, including with the latter the observations at Padua, West Point, and at Naples on the 28th of March, and then made a new determination for the filar-micrometer and ring-micrometer series, in the former of which the values are now considerably less than before, for reasons given above.

It may also be remarked that the probable errors, being obtained from the whole series, rest upon the assumption of equal accuracy through the whole period of observation. This is seen to be very nearly true for the filar-micrometer and instrumental positions, but the observations with the ring-micrometer show a sensible decrease of accuracy with the increasing faintness and diffuseness of the comet. It would be more correct, therefore, to consider the probable error of this series as a function of the time, explicitly or otherwise, but the data are not sufficient for this.

The resulting values of the probable errors and weights are as follows, the unity of weight being that belonging to an observation whose probable error is ±10″.

	Probable Errors.		Log. Weights.	
	α	δ	α	δ
Filar-micrometer	9″.55	7″.41	0.02012	0.13011
Ring-micrometer	11.91	17.51	9.92420	9.75677
Trevandrum	15.25	14.11	9.81681	9.81980
Kremsmünster	14.61	11.84	9.83526	9.92663

The sextant observations of Feb. 28 are very valuable, and fortunately not liable to great error of eccentricity, since in the one case the measured arc is small, and in the other the error, if existing, is nearly eliminated in the determination of the hour-angle. I have given to each of the observations of this date the weight of unity. The sextant observations at the Cape of Good Hope are now rendered of less importance by the acquisition of the micrometer series, which they could not safely contradict, and they have therefore not been retained in the subsequent discussion.

Returning now with the new system of weights to the residuals furnished by Elements V., I computed the following table of normals to serve as the basis of the final approximation: —

		C. – O.
Feb. 28.3550	Distance from Sun	+ 0″.5
28.3947	Altitude	—37.4
28.4375	Altitude	+ 2.4

M. T. Berlin.	Δα . cos δ	Log. Weight.	M. T. Berlin.	Δδ	Log. Weight.
March 5.2816	+10″.8	0.02012	March 5.2869	+ 4″.1	0.13011
8.2509	—23.6	.09196	6.2859	— 3.9	.13011
9.2479	— 6.9	.09196	8.2681	+13.1	.18287
10.2458	—11.5	.09196	9.2636	— 3.3	.18287
11.3390	—36.4	.14584	10.3053	—22.8	.13011
13.2599	— 3.1	.09196	11.3400	—37.9	.00031
14.2483	— 7.4	0.09196	13.2770	— 0.4	.18287
15.1185	+23.8	9.81681	14.2654	+ 1.6	0.18287
16.2753	—14.8	0.09196	15.1185	+ 6.7	9.84980
17.3274	+ 8.6	.26120	16.2934	— 0.7	0.18287
18.3810	+ 1.5	.38311	17.3274	—12.8	.32506
19.3831	+ 2.5	.45446	18.3932	— 6.0	.39928
20.3551	+ 2.6	.38452	19.3779	— 9 2	.50276
21.3507	— 0.4	.43125	20.3195	— 1.2	.35467
22.4043	— 1.4	.44262	21.3507	— 3.8	.44022
23.4010	— 1.3	.17808	22.4038	+ 0.8	.48425
24.4404	— 3.8	.28756	23.4009	—20.4	.22819
25.3859	+ 7.2	.39582	24.4404	— 8.9	.39532
26.3740	+ 9.0	.30910	25.3990	+ 4.5	.37639
27.3185	+ 2.0	.30084	26.3742	— 6.1	.44558
28.4816	— 0.6	.23682	27.3185	+ 3.1	.38127
29.3798	— 5.5	.45548	28.3271	+ 2.0	.22819
30.3304	+ 7.0	.41924	29.3614	— 4.7	.41790
31.3172	— 5.5	.39312	30.3294	+14.1	.38856
April 1.3901	+ 5.8	.38733	31.3176	— 2.7	.40446
2.4210	— 7.6	.27808	April 1.3642	+ 1.5	.32911
3.3206	+12.6	.09730	2.4217	+ 1.0	.38100
5.4217	— 3.5	.19964	3.3101	+10.6	.13011
6.4169	—20.7	.19964	5.4229	+ 7.1	.19662
7.4295	+ 3.6	.17063	6.4169	—24.5	.19662
8.2791	— 9.8	.02012	7.3136	+23.8	.20190
9.4226	+ 8.7	0.09730	8.2835	+13.1	.13011
10.5848	—50.2	9.92420	9.4250	+36.0	.16590
15.3229	+32.8	0.02012	15.3229	+ 1.0	.13011
18.3031	—42.0	.02012	18.3071	+ 7.8	.13011
19.2903	—11.5	0.02012	19.2942	+20.2	0.13011

(*To be continued.*)

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SOLAR ECLIPSE OF JULY 28, 1851.

FROM A LETTER OF GEORGE P. BOND.

Observations made in Sweden, during the Total Eclipse.

The place of observation, Lilla Edet, latitude 50° 7′, longitude 12° 8′, was chosen, to be as near as possible on the central line, which is, I believe, by Mr. Paine's calculations, in latitude 58° 5′, longitude 12° 8′, at the nearest point.

Mr. Paine's article in the *Daily Advertiser*, by the way, has been very useful, and was in great demand just before the eclipse, for laying down the central line.

The telescope of 21 lines aperture, by Frauenhofer, for which I am greatly indebted to Mr. Rümker of the Hamburg Observatory, had a field of about 55′, power 30, more or less. The definition was exceedingly good, and all attending circumstances as favorable as could be desired.

1st. Previously to the first contact, I made a sketch of some spots near the sun's limbs, both preceding and following. There were, beside the dark spots, numerous bright ones.

Observed first contact, nothing remarkable.

2d. Soon after the first contact, there was a slight atmospheric disturbance of the limb of the moon. I noticed particularly, that the undulations (such as we usually see) were from the horizon towards the zenith. This has some importance in connection with what was afterward seen in the motion of the beads on the cusps in the opposite direction.

The contour of the lunar mountains was exhibited in great beauty. Towards the south side, they were quite high enough to produce a sensible distortion of the cusps, afterwards noticed. My attention was mostly directed to the south cusp, which, seven minutes before the totality, exhibited a curious figure, — seen also by Mr. Carrington, whose station was about one mile and a half to the northwest of mine. The outline of the irregularity was clear and distinct, as if it was occasioned by a mountain.

3d. As the time of total obscuration drew near, I watched the same cusp, with only an occasional glance at the surrounding landscape, of which the station commanded an extensive view. Just before the eclipse was total, this cusp — I only watched this one — was divided into beads of light, which moved slowly toward the point of the cusp, and disappeared. As far as I could perceive, the phenomenon of the shortening of this cusp was effected entirely in this manner. I think the appearance was such as could not be accounted for by the mountains on the moon's edge. The black spaces separating the beads, by spreading faster towards the point of the cusp, may have given the appearance of motion. The beads formed at this cusp five or ten seconds before the time of total obscuration.

My attention was drawn so closely to this appearance of motion in the beads at the extremity of the cusp, that I had no opportunity of noticing what took place on other parts of the limb.

It is of some importance to notice, that the outline of the dark intervals between the beads was well defined, and the motion opposite to that of the atmospheric undulations, which had taken place half an hour previous.

4th. Though well aware that the total phase takes place with a suddenness apt to startle the coolest observer, I was not sufficiently collected, for ten or twenty seconds after the sunlight disappeared, to withdraw the screen of colored glass from the eyepiece. But through it the corona was instantly visible; the screen is just dense enough for the eye to bear full sunlight through the telescope, — too thin for ordinary use. I shall keep it by me, as it will give a good estimate of the degree of light from the corona. On this account, my having lost about twenty seconds before withdrawing the screen is of less consequence. My impression is that the red flames were also seen with the screen on.

5th. On removing the screen, I was filled with inexpressible admiration at the glorious spectacle of the corona, and the prominences of rose-colored flame which surrounded the moon. The appearance of the corona is not so well described by calling it a ring, or halo of light, as by comparing it to the "glory," or "aureola," employed by painters to designate the person of the Saviour. It proceeded, without an intervening space, directly from the moon's edge, where it was by far the brightest, its radiations extending to a distance of perhaps the sun's semidiameter; but it is impossible to define precisely its limits, as it had no definite outline externally; internally it was cut off by the moon's circumference.

Its light was pure white. I saw no external rings, but did not look expressly for them, nor whether it was uniform in all its parts. The testimony of intelligent persons in the vicinity is strong to the effect that there was a "bush" of light, half way between the upper and the left-hand limb. Its light I did not consider uniform throughout, but rather of a radiating character.

The observation of most importance which I made upon the corona was, that it was certainly visible on the limb of the moon *after* the sun's limb had reappeared. Of this I am absolutely certain. I saw the limb of the moon which was entirely off of the sun, after the total phase was over, with entire distinctness, by the naked eye, and the light of the corona bordering it, — strongest on the side opposite to the exposed portion of the sun's disc. I may say that my visual organs have no power of conveying to my mind greater certainty than I have of the above fact. It was as plain as the sun itself.

I made no attempt to judge whether the corona was concentric with the sun, or with the moon.

6th. At the moment of removing the screen, perhaps twenty seconds after the total obscuration commenced, my eye was directed to the portion of the corona in the direction of the moon's advance. I instantly saw there one of the rose-colored prominences (*a*).

As soon as I could withdraw my eye from this gloriously beautiful sight, I saw other and even more remarkable appearances upon the opposite limb. The color of all was a decided rose, or pinkish-carmine; like the roseate hue of auroral streamers, but far more intense. I must not be thought to compare the two together in any other particular than that of color.

Of the shape of the prominences I cannot speak with certainty, but my impression is that they were generally broadest next to the limb, but not brightest there.

As my intention was almost immediately drawn from (*a*), I had time only to remark that it appeared near where one of the large spots had been seen on the limb, and that it faded away, or else was eclipsed, which of the two I am not able to say, before the end of the total phase, and I think during the first half of its continuance. It certainly did disappear, for I looked for it expressly before the end of totality, and it was not visible. There might have been others on this limb, but time was wanting even for a hasty glance for them.

One remark I may here make with respect to all the prominences; that they had rather the appearance of flames, not in sudden motion, than of mountains, or of solid projections from the sun, to which they seemed to belong rather than to the moon, if they are not optical phenomena.

I very soon left the prominence (*a*), with a hasty glance at other parts of the limb, but so hurriedly, that my not having seen other peculiarities can have no weight compared with direct testimony that such existed, and fixed my attention on the great flame extending from the opposite limb, and *from* which the moon was moving. I think that I first saw this at some time previous to the first thirty seconds of totality.

I am confident that its surface was not uniformly illuminated, but that it was made up of streaks of rose-colored flame, somewhat bent or interwoven together. I have heard of no comparison which has satisfied me so well as one made by Mr. Carrington, of its resemblance to a flame bursting through the roof of a house; only I should be pretty confident that there was no sudden waving, or quick motion of any kind.

At its upper extremity it extended towards the flame (*c*). The forks of flame of which (*b*) seemed to me made up, I thought were not all connected with the limb, nor diverging from it.

The fact of most importance, of which I can speak with full certainty, with regard to (*b*) and (*c*) is, that the two were connected in a most remarkable manner by an arch of light, fainter than that of the prominences. Possibly there was more than one; at any rate, I thought the light of the corona to be broken up in the vicinity of (*b*) and (*c*) in an irregular manner, by some less certain connections; of the existence of the arch I am entirely sure.

Its curvature was towards the limb, with a radius less than that of the sun's edge.

I think a wave-like motion in the flames could hardly have escaped my attention, unless it were feebly exhibited.

I cannot say in what precise manner the increase of brightness of the prominences on the limb *from* which the moon was moving, and which was first to be uncovered, was effected, whether by their emerging from the moon's limb, or otherwise; but it certainly took place. My impression is, that some portions of rose-colored light existed, quite detached from the limb; but between the number of things to be attended to in the short interval of the total phase, which lasted less than four minutes, and the suddenness and overpowering effect of the whole scene, which is perhaps the most sublime of all the phenomena of nature, it is quite impossible to retain a clear and connected impression of all that occurs.

Of all the phenomena of the total phase, I can speak with most confidence of the following, which preceded the moment of its termination.

My eye and attention were fixed on the portion of the moon's limb where the phenomena took place, and what I there saw was seen with perfect distinctness.

At least ten seconds before the edge of the sun reappeared, I was sure, from a decided illumination of the moon's limb, that the end of the total phase was close at hand. I had not looked at my watch for the last ten minutes, and had taken little note of time during the interval. But there was no mistaking the warning which preceded the bursting forth of sunlight.

The rose-light of the prominences extended in a faint edging over the limb, until, at the moment before the disc of the sun flashed out from behind the moon, its edge through an arc of nearly 60° was bordered by a narrow fringe of rose-tinted light. This glow of light, the instantaneous forerunner of the white sunlight, heralded its approach with as much certainty to my mind, as if I had been witnessing its rising above the terrestrial horizon.

FROM A LETTER OF DR. B. A. GOULD.

Altona, 1851, *September* 1.

The eclipse of July 28 seems to have been most thoroughly observed. The towns in the path of the shadow were filled with astronomers of all nations, professional and amateurs. The results have in many cases been published, as you will have seen, in the *Astronomische Nachrichten* and *Comptes Rendus.* And even now I am daily hearing of still more observations and results. The data of Mr. Airy appear to have been exceedingly accurate, and Mr. Hind has pointed out a beautiful illustration of the accordance of the predicted and observed boundaries of the path of the shadow. The vessels passing through the sound by Elsinore saw the Swedish coast on the one side in the gloom of deep shadow, while Denmark opposite was glowing in bright sunlight.

FROM A LETTER OF PROFESSOR W. MITCHELL TO LIEUTENANT C. H. DAVIS.

Nantucket, 1851, *July* 29.

The morning was without a cloud, but the wind was so high at the beginning of the eclipse that I have less confidence in the observation, though even this result may be considered fair.

At the end the wind had fallen, and at the moment of the event the telescope was without tremor.

The chronometer employed was selected from a number, and its condition and rate were obtained by meridian transits of the sun on the 5th, 6th, 8th, 20th, 25th, 26th, and 27th inst., and again after the eclipse on the 28th.

Repeated measurements were made of the cusps; but so great was the tremor from the wind that the results are of no value.

The following are my periods: —

	h.	m.	s.	
Beginning,	7	55	34.6	M. T. Nantucket.
End,	9	33	47.1	
Duration,	1	38	12.5	

LETTER OF PROFESSOR A. D. BACHE TO THE EDITOR.

Coast Survey Station, Mount Pleasant, Me., 1851, *August* 14.

The following observations of the solar eclipse of July 28, 1851, were made at the Coast Survey Station at Mount Pleasant, Oxford County, Maine; approximate latitude 44° 1′ 34″ and longitude $4^{\mathrm{h}}\ 43^{\mathrm{m}}\ 19^{\mathrm{s}}$.

By Lieutenant W. P. Trowbridge, Corps of Engineers, assistant in the Coast Survey, with telescope of 20-inch theodolite, aperture 3 inches, power 140, and through a deep-red colored glass. End of eclipse $9^{\mathrm{h}}\ 38^{\mathrm{m}}\ 27^{\mathrm{s}}.48$, mean time of station.

By Mr. Edward Goodfellow, of the Coast Survey, with a telescope of 3 inches aperture, and power 85, the beginning through a combination of red and green glasses, both of light shades, and the end through a dark-red glass.

	h.	m.	s.	
Beginning of the eclipse,	7	50	32.92	M. T. of station.
End of eclipse,	9	38	29.27	

The time was determined by the transit instrument used in connection with the observation for latitude and azimuth of the station.

Another observation was made, but with a reconnoitring telescope of so low a power that the results are of no special value.

A. D. BACHE,
Superintendent U. S. Coast Survey.

CAMBRIDGE.

The eclipse was observed at Cambridge, Mass., as follows. For the beginning, expressed in mean solar time of the Observatory, —

By R. T. Paine, using a refracting telescope of 54 inches focal length and 3 inches aperture, power 40, $7^{\mathrm{h}}\ 49^{\mathrm{m}}\ 35^{\mathrm{s}}.28$.

By S. C. Walker. Equatorial refracting telescope of 5 feet focal length, and 4½ inches aperture, power 50, $7^{\mathrm{h}}\ 49^{\mathrm{m}}\ 35^{\mathrm{s}}.34$.

By W. C. Bond. Daguerreotype telescope with achromatic eye-piece, focal length 9 feet, sun's image thrown on a white field, $7^{\mathrm{h}}\ 49^{\mathrm{m}}\ 38^{\mathrm{s}}.97$.

At the end of the eclipse the sun was obscured by clouds.

NEW YORK.

The eclipse was observed at the Observatory of Columbia College, New York, by Professor C. W. Hackley. The first contact or beginning of the eclipse took place at $7^{h.}\ 35^{m.}\ 55^{s.}$, and the last contact or end at $9^{h.}\ 11^{m.}\ 50^{s.}$, mean solar time. The observations were made with an equatorial instrument of 6 inches aperture.

OBSERVATION AT PRINCETON, N. J., BY PROFESSOR STEPHEN ALEXANDER.

1851, *July* 27, 28.

Longitude of the place of observation about $0^{s}.25$ west of Nassau Hall. Latitude the same with Nassau Hall (40° 20′ 11″ north).

Telescope, a refractor by Utzschneider and Fraunhofer. One of the terrestrial eye-pieces was employed; amplifying power 80. The aperture of the object-glass was reduced by capping to 1.1 inches, to admit of the use of a screen composed of one green and two violet glasses, through which the image of the sun appeared *white* and quite distinct, the adjustment being made by some small spots which were visible.

	h.	m.	s.	
Beginning of the eclipse, at	19	32	35.5	Mean Solar Time.
End of the eclipse,	21	7	22.8	

An indentation was still suspected at about $0^{s}.7$ later than the end as here recorded; but it had become doubtful for full two seconds previous to the same, the direction of the moon's motion being oblique to the sun's limb. The moon's edge was visibly uneven; several prominences were noticed, but no peculiar irregularity was seen at either of the contacts.

Professor Richard S. MacCulloh made some observations with a polarizing apparatus, which have not yet been arranged.

1851, *July* 29.

In my note of last evening, I did not state the focal length of the object-glass of the telescope. It is 48 inches German or French measure, or 51 English. The actual aperture exceeds three inches, though it was reduced as mentioned. The telescope seems to be 22 of Fraunhofer's Catalogue (*Astr. Nachr.* 405).

STEPHEN ALEXANDER.

FROM A LETTER OF MR. SAMUEL J. GUMMERE.

Burlington, New Jersey, July 29.

I had very satisfactory observations of the beginning and end of the solar eclipse yesterday with a five-foot equatorial, as follows: —

	h.	m.	s.
Beginning,	7	31	54
End,	9	5	32

SAMUEL J. GUMMERE.

PHILADELPHIA.

The eclipse was observed at Philadelphia High School Observatory by Mr. Riggs with the great Equatorial, and by Mr. Mason with a smaller instrument. Owing to the great heat of the sun in the focus of the large instrument, the colored screen glass did not sufficiently protect his eyes; and Mr. Riggs, therefore, prefers Mr. Mason's time of beginning.

		h.	m.	s.	
Beginning,	by Mason,	19	30	25	Mean Solar Time.
	by Riggs,	19	30	29	
End,	by Mason,	21	3	34	
	by Riggs,	21	3	36	

LETTER FROM LIEUTENANT MAURY TO HON. WILLIAM A. GRAHAM, SECRETARY OF THE NAVY.

[Communicated by Lieutenant Maury.]

I have the honor to report herewith, for your information, the observations made upon the solar eclipse of the 28th instant.

The observers were Professor Hubbard and Mr. Ferguson, the former with the telescope of the Prime Vertical Instrument lifted on its reversing Y's for the beginning, and with the Comet-seeker for the end. Mr. Ferguson's were both made with the large Equatorial. He reports his observation upon the first contact as a little too late.

Observations of the Eclipse.

	Commencement. d. h. m. s.	End. h. m. s.	Observer.
M. T. Washington, July	27 19 21 32.77	20 50 37.94	Mr. Ferguson.
" " "	29.59	38.08	Professor Hubbard.

National Observatory, 1851, *July* 30.

M. F. MAURY.

LETTER FROM PROFESSOR JAMES CURLEY TO THE EDITOR.

Georgetown College, D. C., 1851, *August* 13.

I OBSERVED the last contact of the sun and moon in the eclipse of the 28th July, and got $8^{h.}\ 50^{m.}\ 30^{s.}.05$ Georgetown time; we are $6^{s.}.2$ west of the Naval Observatory, which gives $8^{h.}\ 50^{m.}\ 36^{s.}.25$ for the Washington mean time of the last contact at this place. The telescope was a four-foot one, with a three-inch object-glass, and a power of 70. The sun-glass gave a delicate greenish-white image.

JAMES CURLEY.

LETTER OF LIEUTENANT MAURY TO HON. WILLIAM A. GRAHAM, SECRETARY OF THE NAVY.

1851, *September* 3.

THE star of comparison with *Hygea* on the night of October 21, 1850, has disappeared. It is not now to be found where it then was. Hence I infer that it is probably an unknown planet.

My attention was first called to the planetary character of this star by a remark of Mr. HIND, in a letter to W. C. BOND of Cambridge, which Mr. BOND had the kindness to communicate to me.

I directed Mr. FERGUSON to examine the proper part of the heavens for the star in question. This he did on the night of August 29, 1851, and reported it to be missing. These circumstances have induced me to have a careful examination made of the observing books of that time. It turns out that this star was observed by Mr. FERGUSON with the large Equatorial on the nights of the 16th, 21st, and 22d of October, 1850, and that those observations, had there been sufficient force at the Observatory for their immediate reduction, would then have revealed to us the character of this star.

Its observed places were, —

1850.	α h. m. s.	δ ° ′ ″
Oct. 16	19 17 40.605	—20° 45′ 6″.58
22	19 17 42.364	—20 45 3.42

It is described in our note-books as a star of the 9.10 magnitude.

FROM LETTERS OF DR. PETERSEN TO THE EDITOR.

Altona, 1851, *August* 29.

SINCE the last new planet, discovered at Naples by DE GASPARIS on the 29th of July, is difficult to find, I hasten to send you the following elements therefor, which Professor ENCKE has computed from the observations at Naples as late as August 12.

ELEMENTS. — 1851, August 5, $0^{h.}$ Berlin.

M	172° 10′ 21″.6
π	112 18 15.6
☊	292 51 1.8
i	13 0 18.5
φ	7 50 44.2
Log. a	0.380110
μ	954″.645

Professor ENCKE remarks that the Neapolitan observations are hereby very well represented.

Altona, September 5.

ELEMENTS of the 15th asteroid: — 1. By Messrs. WESTPHAL and KLINKERFUES in Göttingen, computed from the observations at Naples, July 29, August 5, and August 12.

1851, August 5, $0^{h.}$ Berlin.

M	170° 40′ 26″.5	
π	113 25 14.5	True Equinox, August 5.
☊	292 48 47.9	
i	13 3 5.8	
Log. a	0.3803271	
" e	9.1391746	
" μ	2.9795160	

2. By Professor **Virgilio Trettenero** at Geneva, from the observations at Naples, July 25, August 10, and Geneva, August 21.

1851, July 30.0, M. T. Greenwich.

M	240° 36′ 39″.9
π	56 23 14.4
☊	293 42 6.3
i	12 1 34.2
φ	7 13 54.3
Log. a	0.393714
μ	910″.82

3. By G. **Rümker** at Hamburg, from the observations at Naples, July 29, August 12, and at Hamburg, August 29.

1851, September 1.0, M. T. Greenwich.

M	288° 59′ 6″.82	
π	26 26 49.32	Mean Equinox, Jan. 0.0, 1851.
☊	293 59 32.85	
i	11 36 55.05	
φ	11 16 8.88	
Log. a	0.4236613	
" e	9.2909642	
" μ	2.9145146	

Observations at Hamburg by Mr. C. **Rümker**: —

1851.	M. T. Hamburg. h. m. s.	R.A.	Decl.	
August 14	9 30 48.0	272° 7′ 57″.4	—24° 52′ 47″.3	Corrected for parallax.
19	9 10 30.6	271 55 50.8	24 32 46.5	
28	8 25 43.9	272 2 57.3	23 56 0.0	
29	8 37 24.7	272 6 1.1	23 51 51.2	
30	9 5 32.2	272 9 22.9	23 47 57.9	Not corrected for parallax.
31	8 29 41.5	272 13 13.5	—23 44 14.3	

At Padua: —

	M. T. Padua. h. m. s.	App. R.A. h. m. s.	App. Decl.	
August 13	9 46 55.8	18 8 46.90	—24° 58′ 19″.2	4 Comparisons.
14	10 7 19.5	8 31.77	53 41.9	3 "
15	8 33 50.6	8 18.53	49 37.7	Meridian.
16	8 29 43.7	8 7.36	45 20.6	"
17	8 25 37.4	7 57.11	41 5.5	"
20	8 13 32.6	7 39.91	28 27.3	"
21	8 9 34.6	7 37.83	24 17.9	"
22	8 5 37.9	7 36.96	20 2.0	"
23	8 1 42.9	7 37.86	16 6.1	"
24	7 57 50.5	18 7 41.42	—24 12 3.3	"

At Naples: —

1851.	M. T. Naples. h. m. s.	App. R.A. h. m. s.	App. Decl.
July 29	11 44 53.7	18 15 59.94	—26° 3′ 51″.0
30	10 17 59.9	15 22.17	25 59 49.1
31	10 52 57.0	14 41.26	55 1.8
Aug. 2	11 17 37.9	13 26.89	46 26.1
3	9 31 4.2	12 53.98	41 57.4
4	12 9 18.0	12 18.25	37 3.9
5	11 54 22.6	11 47.17	32 31.2
8	11 40 32.5	10 25.09	19 30.9
9	10 11 23.3	10 2.93	15 13.9
10	10 2 50.1	9 41.03	10 46.0
11	9 11 24.7	9 21.72	6 31.1
12	10 20 28.5	18 9 1.79	—25 2 10.8

From Professor **Secchi**, at Rome, I have received the following observations of this planet: —

1851.	M. T. Rome. h. m. s.	App. R.A. h. m. s.	App. Decl.
August 6	9 12 16.5	18 11 21.34	—25° 28′ 58″.4
7	9 7 53.4	18 10 54.05	—25 24 32.1

1851.	M. T. Rome.	App. R.A.	App. Decl.
	h. m. s.	h. m. s.	° ′ ″
August 8	9 3 31.9	18 10 28.38	—25 20 4.5
9	8 59 12.4	10 4.70	15 39.7
10	8 54 54.2	9 42.37	11 14.2
11	8 50 37.9	9 21.94	6 56.1 ?
12	8 46 23.4	18 9 3.23	—25 2 53.1

OBSERVATIONS AT THE HAMBURG OBSERVATORY.

[Communicated by Mr. C. Rümker, Director of the Observatory.]

PARTHENOPE.

1851.	Hamburg M. T.	App. α	δ	1851.	Hamburg M. T.	App. α	δ
	h. m. s.	° ′ ″	° ′ ″		h. m. s.	° ′ ″	° ′ ″
July 24	12 30 22.7	28 30 43.2	+6 57 45.2	Aug. 2	12 52 9.7	30 45 56.4	+7 22 51.8
27	14 31 31.7	29 19 24.5	+7 7 16.0	4	12 30 26.7	31 12 45.5	+7 27 1.0
30	12 31 42.0	30 3 22.0	+7 15 20.8	5	12 37 57.0	31 25 52.2	+7 28 57.9

IRENE.

[Not corrected for parallax.]

1851.	Hamburg M. T.	R.A.	Decl.	1851.	Hamburg M. T.	R.A.	Decl.
	h. m. s.	° ′ ″	° ′ ″		h. m. s.	° ′ ″	° ′ ″
June 18	10 52 0.2	234 36 14.2	—13 38 45.3	July 1	10 57 56.6	233 20 46.1	—15 31 42.3
19	10 47 29.9	234 27 59.5	14 42 23.0	2	10 53 24.8	233 18 4.8	15 36 22.1
21	10 40 46.5	234 12 27.8	14 49 52.3	3	11 23 22.7	233 15 51.3	15 40 53.8
28	11 34 57.4	233 31 33.8	15 18 48.1	22	10 41 5.0	233 53 20.0	17 18 43.2
29	11 13 52.6	233 27 35.9	15 22 54.3	24	10 30 29.0	234 5 47.6	—17 29 44.5
30	10 58 51.8	233 23 58.4	—15 27 17.7				

Ephemeris of Irene, for 9h. 36m. *M. T. Berlin, computed by* Mr. George Rümker.

1851.	α	δ	Log. △	1851.	α	δ	Log. △
	h. m. s.	° ′ ″			h. m. s.	° ′ ″	
Oct. 3	16 54 38	—23 55 0		Oct. 19	17 20 52	—24 53 0	
4	16 56 13	23 59 1		20	17 22 35	24 56 1	
5	16 57 48	24 3 2	0.45414	21	17 24 17	24 59 0	0.48441
6	16 59 24	24 7 2		22	17 26 0	25 1 8	
7	17 1 0	24 11 1		23	17 27 43	25 4 6	
8	17 2 37	24 14 9		24	17 29 26	25 6 4	
9	17 4 14	24 18 7	0.46214	25	17 31 10	25 10 0	0.49127
10	17 5 52	24 22 4		26	17 32 55	25 12 5	
11	17 7 30	24 26 1		27	17 34 40	25 15 0	
12	17 9 9	24 29 7		28	17 36 25	25 17 4	
13	17 10 48	24 33 3	0.46985	29	17 38 10	25 19 7	0.49785
14	17 12 28	24 36 7		30	17 39 56	25 21 9	
15	17 14 8	24 40 1		31	17 41 42	25 24 0	
16	17 15 48	24 43 4		Nov. 1	17 43 28	25 26 1	
17	17 17 29	24 46 7	0.47727	2	17 45 15	—25 28 2	0.50417
18	17 19 10	—24 49 9					

SECOND COMET OF 1851.

1851.	Hamburg M. T.	☄ α	☄ δ	1851.	Hamburg M. T.	☄ α	☄ δ
	h. m. s.	° ′ ″	° ′ ″		h. m. s.	° ′ ″	° ′ ″
Aug. 4	11 16 11.7	209 59 38.4	+32 48 20.3	Aug. 22	9 36 19.6	219 33 30.4	+41 18 1.0
5	11 10 0.7	210 26 21.2	33 15 36.5	24	9 49 35.1	220 53 51.4	42 18 2.2
6	10 47 25.1	210 53 15.7	33 42 25.8	25	9 16 51.5	221 36 36.7	42 48 36.4
19	10 46 6.3	217 42 26.0	39 51 13.1	28	9 20 36.7	223 47 18.1	44 18 52.7
21	9 40 52.3	218 55 17.2	+40 48 37.7	29	10 38 26.2	224 36 27.8	+44 51 15.3

This comet's nucleus is very distinct and fine.

Elements, as calculated by G. Rümker.

T	1851, August 26.216505
π	309° 51′ 7″
☊	225 1 1
i	40 9 24
Log. q	9.999860

Motion Direct.

NOTICE.

Mr. Josiah Lyman, of Lenox, Mass., has recently constructed a reflecting telescope of 16 feet focal length, and with a clear aperture of 9½ inches. The figure of the speculum appears to be remarkably correct, for Mr. Lyman has succeeded, with a power of 550, in separating, among others, the close double stars ζ Boötis, π Aquilæ, τ and λ Serpentarii, and ε Equulei. The whole performance of the instrument seems to be highly satisfactory, and worthy of more extended notice.

H.

⁂ Professor Major, of the Washington Observatory, has communicated the following Corrigendum to the British Nautical Almanac for 1854. In the Preface, p. ix., line 9, for 997″.79182, read 977″.79182.

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VOL. II. CAMBRIDGE, 1851, NOVEMBER 20. NO. 8.

ON THE ORBIT OF THE GREAT COMET OF 1843.

BY PROFESSOR J. S. HUBBARD.

(*Continued from* Vol. II. p. 48.)

THE equations being now fully prepared, I multiplied them by their respective weights, and proceeded to solve them, using the form of PLANA's Control,* but making three independent eliminations instead of two. The results of the solution are: —

Log p = 1.1764623	l (aa . 5) = 0.8805866	(nn . 6) = 25103″.567	$\Delta T = +\ ^{d.}.0064042$
Log q = 2.4381952	l (bb . 5) = 7.9828154	(nn . 6) = 25103.570	$\Delta n = +14'\ 27''.35$
Log r = 2.0791033	l (cc . 5) = 8.6497865	(nn . 6) = 25103.547	$\Delta \omega = +11\ 14.69$
Log s = 1.8210083	l (dd . 5) = 9.2400890	(nn . 6) = 25103.551	$\Delta i = +\ 2\ 35.24$
Log t = 1.6178045n	l (ee . 5) = 0.1382205	(nn . 6) = 25103.574	$\Delta q = -.000092855$
Log u = 1.8494428	l (ff . 5) = 9.5685041	(nn . 6) = 25103.572	$\Delta e = +.000043596$

The probable error of a single normal = ±12″.865.

Substituting the above values of ΔT, Δn, &c., in the original equations, we have, —

Feb. 28	Distance from sun	C. — O. = —11″.2
28	Altitude of comet	" = —31.4
28	" "	" = + 5.8

	$\Delta\alpha . \cos\delta$	$\Delta\delta$		$\Delta\alpha . \cos\delta$	$\Delta\delta$
March 5	+34″.9	+10″.6	March 26	+ 7″.8	— 5″.1
6		+ 3.5	27	+ 1.2	+ 3.5
8	— 5.1	+21.7	28	— 1.1	+ 1.8
9	+ 8.9	+ 5.6	29	— 5.5	— 5.4
10	+ 1.8	—13.7	30	+ 7.4	+12.8
11	—25.9	—28.9	31	— 4.7	— 4.5
13	+ 3.4	+ 8.1	April 1	+ 7.0	— 0.8
14	— 2.9	+ 9.7	2	— 5.8	— 1.8
15	+26.9	+14.4	3	+14.7	+ 7.3
16	—13.2	+ 6.4	5	— 0.4	+ 2.7
17	+ 9.1	— 6.4	6	—17.1	—29.3
18	+ 1.2	— 0.2	7	+ 7.6	+18.6
19	+ 1.6	— 3.9	8	— 5.3	+ 7.3
20	+ 1.3	+ 3.5	9	+13.6	+29.9
21	— 2.0	+ 0.2	10	—41.9	
22	— 3.1	+ 4.2	15	+39.7	— 7.8
23	— 3.2	—17.6	18	—31.3	— 2.2
24	— 5.4	— 6.8	19	— 3.8	+ 9.8
25	+ 5.8	+ 6.0			

Applying now the corrections to Elements V., we have, —

ELEMENTS VI.

T	1843, Feb. 27.4512312	M. T. Berlin.
n	1° 26′ 50″.93	M. Equinox, 1843.0.
ω	82 43 47.28	
i	144 21 26.32	
q	0.005486532	
e	0.999936479	
Log (1 — e)	5 8029173	

These elements give the best possible representation of the whole series of observations, and may in this respect be considered as final. But in attempting to determine their limits of error, it is evident that, in allowing the ring-micrometer and instrumental observations to have weight in the solution, we have increased the probable error of the results much beyond what would have been given by the filar-micrometer series alone. And since the last extends through the whole period of the comet's visibility, while the others are grouped together into the short space of time when the comet was visible in smaller telescopes, I have judged it best to determine the weights and limits of error of the results from the filar-micrometer observations, including with them only the observations of the 28th of February. And while computing these weights, I have not hesitated to introduce into the computation the residuals belonging to these observations, in order the more completely to remove any yet outstanding effect of terms of the second order in the coefficients, as well as of the uncertainty consequent on the previous use of the other observations.

(*To be continued.*)

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* *Zeitschrift für Astronomie*, VI. p 249.

MOON AND MOON-CULMINATING STARS OBSERVED AT HAMBURG.

[Communicated by Lieutenant MAURY.]

1850.	Star's Name.	Apparent R A.	Apparent Declination.
		h. m. s.	° ′ ″
Jan. 20	ε Piscium	0 55 8.872	+7 4 45.7
	e Piscium	1 0 38.200	4 51 10.6
	Moon I.	1 25 58.891	3 21 29.5
	ο Piscium	1 37 28.309	8 23 57.1
	ξ Ceti	2 5 2.866	8 8 20.7
21	ξ' Ceti	2 5 3.077	8 8 18.6
	Moon I.	2 18 33.454	7 42 48.1
	ν Ceti	2 28 0.400	4 55 59.4
	845 B. A. C.	2 36 50.292	9 28 30.8
Feb. 22	μ Geminorum	6 13 53.628	22 34 59.5
	γ Geminorum	6 29 3.320	16 31 10.3
	Moon I.	6 56 49.879	19 4 8.5
	δ Geminorum	7 11 10.329	22 15 4.3
April 18	Moon I.	7 18 47.871	19 8 42.8
	β Geminorum	7 36 7.780	28 22 58.5
19	Moon I.	8 20 40.920	17 33 51.4
	δ Cancri	8 36 9.429	18 41 59.2
	α Cancri	8 50 17.137	12 25 55.7
22	Moon I.	11 11 27.536	6 43 41.0
May 19	Moon I.	10 58 8.177	8 18 47.5
	ν Virginis	11 38 9.939	7 22 6.6
	β Virginis	11 42 53.908	2 36 29.7
20	Moon I.	11 51 54.529	3 42 13.9
	η Virginis	12 12 15.036	+0 9 57.1
	γ Virginis	12 31 5.013	—0 37 39.7
21	η Virginis	12 12 15.000	+0 9 54.8
	γ Virginis	12 34 4.877	—0 37 39.3
	Moon I.	12 41 6.331	1 2 36.4
	θ Virginis	13 2 12.454	4 44 19.6
	α Virginis	13 17 19.300	10 22 41.6
22	θ Virginis	13 2 12.588	4 44 19.7
	α Virginis	13 17 19.396	10 22 46.5
	Moon I.	13 35 28.219	5 40 46.9
	κ Virginis	14 4 55.566	9 34 30.0
	λ Virginis	14 11 1.673	12 40 48.2
23	κ Virginis	14 4 55.682	9 34 27.1
	λ Virginis	14 11 1.687	12 40 48.6
	Moon I.	14 26 40.485	9 58 59.9
	μ Virginis	14 35 11.236	5 0 16.5
	δ Libræ	14 52 59.567	7 55 18.3
	β Libræ	14 8 58.290	8 49 38.3
June 17	Moon	12 29 53.56	
19	κ Virginis	14 4 55.428	9 34 21.9
	ι Virginis	14 8 10.675	5 16 58.6
	Moon I.	14 11 1.782	8 33 10.9
	α^2 Libræ	14 42 37.144	15 24 57.0
	ξ^2 Libræ	14 48 39.871	10 48 4.6
20	α^2 Libræ	14 42 37.151	15 24 59.1
	ξ^2 Libræ	14 48 39.935	10 48 6.0
	Moon I.	15 1 47.281	12 30 20.4
	γ Libræ	15 27 10.289	14 17 9.5
	η Libræ	15 58 40.397	15 11 29.1
22	Moon I.	16 41 59.506	18 21 40.3
	η Ophiuchi	17 1 48.883	15 32 0.5
	θ Ophiuchi	17 12 50.337	21 50 38.5
July 18	Moon I.	15 37 44.761	14 46 1.5
	δ Scorpii	15 51 30.362	—22 11 34.7
July 18	β' Scorpii	15 56 45.375	—19 23 31.8
21	μ' Sagittarii	18 4 49.931	21 5 29.9
	Moon I.	18 13 9.177	20 33 1.8
	σ Sagittarii	18 46 0.339	21 28 32.3
	ο Sagittarii	18 55 43.947	21 57 14.3
22	ο Sagittarii	18 55 44.027	21 57 12.8
	Moon I.	19 5 31.985	21 6 12.7
	h^2 Sagittarii	19 27 36.893	25 12 23.3
	e^2 Sagittarii	19 33 58.339	16 22 5.1
Aug. 18	ν Sagittarii	18 45 9.084	22 55 32.7
	Moon I.	18 48 24.519	21 10 39.9
	π Sagittarii	19 0 52.810	21 15 15.3
19	π Sagittarii	19 0 53.064	21 15 18.14
	h^2 Sagittarii	19 27 36.910	25 12 26.9
	Moon I.	19 40 24 712	20 35 55.
	α^2 Capricorni	20 9 46.226	13 0 5.9
	β Capricorni	20 12 37.219	15 14 47.5
20	α^2 Capricorni	20 9 46.229	13 0 3.3
	β Capricorni	20 12 37.177	15 14 47.5
	Moon I.	20 31 41.267	19 6 12.3
	29 Capricorni	21 7 28.943	15 47 10.5
	ι Capricorni	21 13 55.860	17 27 55.1
Sept. 12	Moon I.	16 43 49.011	18 18 49.21
	η Ophiuchi	17 1 48.120	15 32 · ·
15	ο Sagittarii	18 55 43.518	21 57 16.6
	π Sagittarii	19 0 52.485	21 15 15.6
	Moon I.	19 22 5.803	20 59 47.0
	e^2 Sagittarii	19 33 58.311	16 28 5.6
	α^2 Capricorni	20 9 45.903	13 0 6.7
16	e^2 Sagittarii	19 33 58.257	16 28 5.3
	α^2 Capricorni	20 9 46.011	13 0 7.6
	Moon I.	20 13 41.605	19 48 6.4
	ν Aquarii	21 1 27.430	11 58 19.4
Oct. 13	Moon I.	19 53 50 638	20 34 48.0
	α^2 Capricorni	20 9 45.600	13 0 8.5
Nov. 12	Moon I.	22 3 53.286	—14 40 2.3
1851.			
Jan. 11	α Piscium	1 54 20.150	+ 2 2 21.7
	ξ' Ceti	2 5 6.259	8 8 32.5
	Moon I.	2 11 7.966	6 46 26.4
	845 B. A. C.	2 36 53.505	9 28 41.8
	π Arietis	2 40 58.969	16 50 21.4
14	Moon I.	4 57 12.569	17 46 5.1
	ο Tauri	5 18 41.713	21 48 8.2
	ζ Tauri	5 28 44.975	21 2 39.4
15	ο Tauri	5 18 41.601	21 48 10.9
	ζ Tauri	5 28 45.043	21 2 11.9
	Moon I.	6 0 27.181	19 34 25.2
	μ Geminorum	6 3 57.258	22 34 59.4
	ν Geminorum	6 20 7.535	20 17 58.7
Feb. 7	Moon I.	1 52 29.111	5 6 57.1
	ξ^2 Ceti	2 20 13.649	7 17 11.8
	ν Ceti	2 28 2.749	4 56 13.5
10	λ Tauri	3 52 25 120	12 4 47.2
	γ Tauri	4 11 18.990	15 15 41.7
	Moon I.	4 29 1.846	16 31 51.9
11	Moon I.	5 28 21.461	+18 51 38.3

1851.	Star's Name.	Apparent R.A.	Apparent Declination.
		h. m. s.	° ′ ″
Feb. 11	η Geminorum	6 5 53. · ·	+22 32 37.8
	μ Geminorum	6 13 57.176	22 35 1.4
13	ζ Geminorum	6 55 16.505	20 46 56.5
	δ Geminorum	7 11 13.689	22 15 1.1
	Moon I.	7 36 40.797	20 5 50.6
	θ Cancri	8 23 6.374	18 35 31.4
	δ Cancri	8 36 13.243	+18 41 46.5
23	η Ophiuchi	17 1 49.191	—15 32 4.5
	ν Serpentis	17 12 25.420	12 41 24.6
	Moon II.	17 23 3.463	—20 38 12.5
Mar. 10	Moon I.	5 4 56.477	+18 15 6.0
	ζ Tauri	5 28 44.231	21 2 44.3
	130 Tauri	5 38 44.731	17 39 58.4
14	α^2 Cancri	8 50 20.560	12 25 43.7
	Moon I.	9 14 4.797	16 41 38.3
May 10	σ Leonis	11 13 27.664	6 58 38.5
	Moon I.	11 25 54.041	7 20 42.0
	ν Virginis	11 38 12.695	+7 21 45.3
May 10	β Virginis	11 42 56.910	+ 2 36 7.9
12	θ Virginis	13 2 15.638	— 4 44 27.5
	Anon.	13 16 45.420	3 32 · ·
	Moon I.	13 17 10.568	— 3 27 34.5
June 8	δ Virginis	12 48 6.838	+ 4 12 30.5
	Moon I.	12 58 37.945	— 1 27 23.6
	ζ Virginis	13 27 7.392	+ 0 10 0.0
10	Moon I.	14 47 0.968	—11 36 36.1
11	ζ Libræ	15 19 53.224	16 11 41.0
	γ Libræ	15 27 13 379	14 17 23.9
	Moon I.	15 42 25.140	15 48 19.3
	ψ Ophiuchi	16 15 25.186	19 41 6.3
	5579 B. A. C.	16 32 59.317	17 26 58.5
July 11	4 Sagittarii	17 50 43.752	23 47 45.6
	Anon.	17 58 27.183	21 12 38.0
	μ′ Sagittarii	18 4 53.245	21 5 28.4
	Moon I.	18 11 50.860	—22 28 37.0

The Moon's declinations are not corrected for parallax.

C. RÜMKER.

FROM A LETTER OF LIEUTENANT J. M. GILLISS TO THE EDITOR.

Santiago de Chile, 1851, *August* 24.

During the month and a half of my absence to the northern provinces, there was but little work done by the assistants; clouds being more frequent than ever last winter, though the rains were neither so frequent nor of such duration. I have thus little to tell you of our work that is cheering, more particularly as we shall soon enter on the concluding year of our stay in Chile. Most fortunately, we received a new micrometer screw for the meridian-circle, enabling us to work it every night on the zones, and though it will not be possible to do more than half the amount I had hoped when leaving home, yet we will try and show such work as will not discredit us.

The zone that will be left between the termination of our sweeps and the beginning of those at Washington will be completed by the astronomers of Chile in the same manner; and if the turmoils not unlikely to ensue on the accession of the new President defeat for the present the establishment of the National Observatory here, so earnest is my desire that American astronomy shall map every star in the heavens, that I am willing to come back and resume the work within six months. To do so, however, I would carry out my original plan, and have the axis of the circle a part of its telescope.

I send you another list of errors in Lacaille, observed prior to my visit to the North, and hope when next I write to give you something of more interest.

Errors in Lacaille's Catalogue.

No. 3232. This star does not exist: it is no doubt the same as No. 3240.
" 3438. The nearest star to this place is in R.A. 8^{h} 28^{m} 32^{s} and P. D. 137° 9′.
No. 4078. There is no such star.
" 4136. The nearest star to this place is 9 magnitude, and follows about 12^{s}.
" 4181. The nearest star to this place precedes it 30^{s}, and is 9′ south.
" 4223. The nearest star to this place is 2′ north, and is double.
" 4247. The nearest star as bright as 9 magnitude is 3′ north.
" 4302. The nearest star to this is 7 magnitude, precedes it 20^{s}, and is 5′ north. Brisbane 3017 is there also.
" 4423. About 7′ too far south.
" 4517. No star within 1^{m} in either direction.
" 4551. P. D. in error —3′.
" 4787. I find a very small star corresponding in R.A., but with an error of —2′ in P. D.
" 4795. Does not exist.
" 4900. The nearest star to this place is 7½ magnitude 3′ north.
" 4964. The nearest star follows 25^{s} and is 10′ north.
" 5307. The nearest star is 7½ magnitude, preceding 2^{m} 30^{s}.
" 5333. Does not exist.
" 5887. 6 magnitude, P. D. 3′ too great.
" 5912. No such star found in two searches.
" 6108. P. D. 1′ too great.
" 8106. Does not exist, unless extremely small.
" 8179. } We find two stars with same R.A. and difference
" 8181. } of P. D., but they are 9′ north of these.
" 9228. P. D. 5′ too great.

J. M. GILLISS.

EUNOMIA.

Mr. De Gasparis has selected the name *Eunomia* for the last new planet discovered by him (July 29, 1851), and for a symbol he proposes a heart surmounted by a star, (♡).

LETTER FROM MR. CHARLES RÜMKER, OF THE HAMBURG OBSERVATORY, TO LIEUTENANT MAURY.

Hamburg, 1851, *October* 7.

My son begs of me to send you his elements and his ephemeris of *Eunomia*, with his best respects. I join here my observations of that planet, and of the fourth comet of Brorsen, not corrected for parallax.*

Eunomia.

1851.	Hamburg M. T.	♡ α	♡ δ
	h. m. s.	° ′ ″	° ′ ″
Sept. 6	8 7 17.8	272 44 49.3	23 21 42.0
8	8 25 26.3	272 58 41.5	23 14 17.2
9	8 2 2.0	273 6 0.0	23 10 50.2
18	8 23 3.9	274 30 8.7	22 39 7.0
22	7 35 6.9	275 15 51.6	22 25 22.3
24	7 50 16.2	275 41 25.8	22 18 12.6
25	7 18 3.4	275 53 53.4	22 15 16.2
27	7 50 3.1	276 21 21.9	22 8 16.1
Oct. 4	7 52 53.1	278 5 24.3	21 43 43.8

Brorsen's Comet (1851 II.).

1851.	Hamburg M. T.	☄ α	☄ δ
	h. m. s.	° ′ ″	° ′ ″
Sept. 6	9 37 38	231 49 28	48 59 40
15	9 15 37	243 15 27	53 38 43
18	9 41 21	248 16 46	55 5 11
Sept. 22	9 37 11	256 5 58	56 45 50
26	10 32 40	265 33 59	57 59 31
27	9 44 35	268 4 29	58 10 22

Elements of Eunomia.

1851, October 1.0, Greenwich M. T.

M 293° 49′ 51″.49

π 27 35 37.57 } Mean Equinox,

☊ 293 52 54.76 } Jan. 0.0, 1851.

i 11 43 42.75

φ 10 51 34.29

e = 0.1884017

Log. a = 0.4228496

" μ = 2.9157322

These elements are computed from the observation made at Naples, July 29, and the Hamburg observations of August 29 and September 27. They represent the middle observation.

Calculation — Observation in longitude —0″.07

in latitude 0.00

From the above elements I have computed the following

Ephemeris for 9h. 36m. *Greenwich Mean Time.*

Date.	α	δ	Log. △	Date.	α	δ	Log. △
	h. m. s.	° ′			h. m. s.	° ′	
Oct. 29	19 3 47	—20 . 7.0	0.42314	Nov. 19	19 35 58	—18 21.8	
30	5 13	20 2.5		20	37 35	16.1	
31	6 40	19 58.1		21	39 13	10.2	
Nov. 1	8 7	53.6		22	40 53	18 4.3	0.45844
2	9 34	49.1	0.42968	23	42 32	17 58.3	
3	11 3	44.5		24	44 12	52.2	
4	12 32	39.8		25	45 52	46.2	
5	14 2	35.1		26	47 32	40.0	0.46310
6	15 32	30.3	0.43595	27	49 13	33.8	
7	17 3	25.5		28	50 54	27.5	
8	18 35	20.3		29	52 35	21.0	
9	20 7	15.5		30	54 17	14.5	0.46811
10	21 40	10.5	0.44197	Dec. 1	56 0	7.9	
11	23 14	5.3		2	57 43	17 1.2	
12	24 48	19 0.1		3	19 59 26	16 54.4	
13	26 22	18 51.9		4	20 1 9	47.5	0.47256
14	27 57	49.6	0.44771	5	2 52	40.6	
15	29 32	44.2		6	4 36	33.6	
16	31 7	38.7		7	6 21	26.5	
17	32 44	33.2		8	20 8 6	—16 19.4	0.47675
18	19 34 21	—18 27.5	0.45320				

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* The first of these observations, having already appeared in No. 31 of this Journal, are omitted here.

EPHEMERIS OF PARTHENOPE.

The following ephemeris, computed by Messrs. Luther and Vogel of Berlin, has been kindly communicated by Lieutenant Maury.

0h. M.T. Berlin	α	δ	Log. △	Aberration Time in parts of a day.	0h. M.T. Berlin	α	δ	Log. △	Aberration Time in parts of a day.
1852.	h. m. s.	° ′ ″			1852.	h. m. s.	° ′ ″		
Jan. 1	1 37 26.00	+4 15 45.1	0.300070	0.01139	Feb. 17	2 25 25.79	+10 16 11.2	0.422198	0.01509
2	38 4.24	22 4.2	.303015	.01147	18	26 45.91	24 29.1	.424368	.01517
3	38 43.71	28 28.9	.305949	.01155	19	28 6.64	32 47.4	.426519	.01524
4	39 24.43	34 59.2	.308872	.01162	20	29 27.94	41 5.3	.428651	.01532
5	40 6.33	41 34.8	.311784	.01170	21	30 49.87	49 22.8	.430764	.01539
6	40 49.43	48 15.5	.314685	.01178	22	32 12.35	10 57 39.9	.432857	.01546
7	41 33.69	4 55 1.1	.317574	.01186	23	33 35.41	11 5 56.6	.434931	.01554
8	42 19.09	5 1 51.7	.320151	.01194	24	34 59.04	14 12.6	.436987	.01561
9	43 5.64	8 47.0	.323315	.01202	25	36 23.21	22 28.0	.439024	.01569
10	43 53.30	15 46.7	.326165	.01210	26	37 47.92	30 42.6	.441041	.01576
11	44 42.07	22 50.9	.329001	.01218	27	39 13.17	38 56.3	.443039	.01583
12	45 31.92	29 59.3	.331824	.01225	28	40 38.94	47 9.0	.445017	.01590
13	46 22.84	37 11.8	.334632	.01233	29	42 5.23	11 55 20.7	.446977	.01598
14	47 14.81	44 28.3	.337425	.01241	Mar. 1	43 32.02	12 3 31.2	.448918	.01605
15	48 7.83	51 48.7	.340204	.01249	2	44 59.31	11 40.4	.450840	.01612
16	49 1.87	5 59 12.7	.342968	.01257	3	46 27.09	19 48.5	.452742	.01619
17	49 56.91	6 6 40.3	.345717	.01265	4	47 55.36	27 55.1	.454626	.01626
18	50 52.95	14 11.4	.348450	.01273	5	49 24.10	36 0.4	.456492	.01633
19	51 49.96	21 45.9	.351168	.01281	6	50 53.31	44 4.0	.458339	.01640
20	52 47.94	29 23.5	.353869	.01289	7	52 22.99	12 52 6.1	.460168	.01647
21	53 46.87	37 4.3	.356554	.01297	8	53 53.13	13 0 6.6	.461978	.01654
22	54 46.74	44 48.1	.359221	.01305	9	55 23.71	8 5.2	.463770	.01661
23	55 47.54	6 52 34.6	.361870	.01313	10	56 54.75	16 2.1	.465543	.01667
24	56 49.24	7 0 23.9	.364502	.01321	11	58 26.23	23 57.1	.467298	.01674
25	57 51.83	8 15.7	.367117	.01329	12	2 59 58.16	31 50.1	.469035	.01681
26	58 55.31	16 9.9	.369714	.01337	13	3 1 30.52	39 41.3	.470753	.01687
27	1 59 59.63	24 6.4	.372294	.01345	14	3 3.31	47 30.3	.472453	.01694
28	2 1 4.79	32 5.0	.374855	.01353	15	4 36.53	13 55 17.3	.474135	.01701
29	2 10.79	40 5.6	.377399	.01361	16	6 10.17	14 3 2.0	.475799	.01707
30	3 17.61	48 8.1	.379924	.01369	17	7 44.22	10 44.5	.477445	.01714
31	4 25.23	7 56 12.5	.382431	.01377	18	9 18.67	18 24.7	.479073	.01720
Feb. 1	5 33.61	8 4 18.5	.384919	.01385	19	10 53.53	26 2.4	.480682	.01726
2	6 42.83	12 26.0	.387389	.01393	20	12 28.79	33 37.7	.482273	.01733
3	7 52.77	20 35.0	.389840	.01401	21	14 4.43	41 10.5	.483846	.01739
4	9 3.46	28 45.2	.392273	.01409	22	15 40.47	48 40.7	.485401	.01745
5	10 14.89	36 56.7	.394687	.01416	23	17 16.88	14 56 8.5	.486938	.01752
6	11 27.04	45 9.3	.397083	.01424	24	18 53.67	15 3 33.4	.488457	.01758
7	12 39.91	8 53 22.8	.399460	.01432	25	20 30.83	10 55.5	.489958	.01764
8	13 63.48	9 1 37.2	.401818	.01440	26	22 8.35	18 14.8	.491441	.01770
9	15 7.75	9 52.4	.404157	.01448	27	23 46.21	25 31.0	.492906	.01776
10	16 22.69	18 8.3	.406478	.01455	28	25 24.43	32 44.2	.494353	.01782
11	17 38.31	26 24.8	.408780	.01463	29	27 2.99	39 54.4	.495782	.01788
12	18 54.61	34 41.7	.411064	.01471	30	28 41.88	47 1.6	.497194	.01793
13	20 11.56	42 59.1	.413328	.01478	31	30 21.11	15 54 5.5	.498588	.01799
14	21 29.16	51 16.8	.415574	.01486	April 1	32 0.65	16 1 6.2	.499965	.01805
15	22 47.41	9 59 34.8	.417801	.01494	2	3 33 40.51	+16 8 3.6	0.501325	0.01811
16	2 24 6.29	+10 7 53.0	0.420009	0.01501					

ELEMENTS OF IRENE.

Lieutenant Maury has communicated the following elements of *Irene*, computed by Mr. George Rümker, from the observation made at London, May 19, a mean of the Berlin and Cambridge observations, July 21, and the Cambridge observation, September 20. They represent the middle observation thus :—

Calc. — Obs.

$d\lambda = -0''.04$ $\quad$ $d\beta = +0''.02$

1851, September 20.0, M. T. Berlin.

M	71° 35′ 20″.56	
π	178 42 34.87	Mean Equinox, 1852, Jan. 0.0.
☊	86 50 23.98	
i	9 6 14.49	
φ	9 43 37.83	
Log. e	9.2277759	
" a	0.4123316	
" μ	2.9315092	

LETTER FROM MR. W. C. BOND TO THE EDITOR.

The following elements of Brorsen's comet of August 1,1851, have been computed by Mr. Charles W. Tuttle, second assistant at Harvard Observatory, from our observations of August 23d, 26th, and 29th.

Perihelion Passage, 1851, August 26^d.46269 Greenwich M. S. T.

Longitude of Perihelion, . . .	311° 3′ 38″	Mean Equinox, 1851, Jan. 0.
" " Node, ...	215 30 45	
Inclination, ...	37 41 22	
Log. q	9.98876	

Motion Direct.

W. C. BOND.

LETTER FROM PROFESSOR A. D. BACHE TO THE EDITOR.

Coast Survey Office, Washington, 1851, *November* 15.

By permission of the Hon. Thomas Corwin, Secretary of the Treasury, I inclose you for the *Astronomical Journal* the lists of moon-culminations observed at Sand Key, Florida, in July and August, 1849, with the corresponding observations made for the Coast Survey at other points, or derived from published records. The longitude of Sand Key, as deduced from these observations and the results of Professor Coffin, U. S. N., for Key West, by S. C. Walker, Esq., is also given.

A. D. BACHE,

Superintendent U. S. Coast Survey.

I. *Moon-Culminations observed in* 1849, *at Sand Key Station* (*U. S. Coast Survey, Section* VI.), *by* J. E. Hilgard, Esq., *Assistant C. S., reduced by Professor* A. G. Pendleton, U. S. N., *Assistant C. S.*

Date, 1849.	Object.	Observed R.A.	No. Wires.	Date, 1849.	Object.	Observed R A.	No. Wires.
		h. m. s.				h. m. s.	
July 29	θ Libræ	15 45 16.08	5	Aug. 1	λ Sagittarii	18 18 41.80	5
	β' Scorpii	15 56 42.08	5		ν' Sagittarii	18 45 5.92	5
	5579 B. A. C.	16 32 53.06	5		Moon I.	19 11 50.18	5
	Moon I.	16 36 57.59	5		e^2 Sagittarii	19 33 55.60	5
	η Ophiuchi	17 1 45.94	5	2	ϱ' Sagittarii	19 12 57.48	5
30	5579 B. A. C.	16 32 52.97	5		e^2 Sagittarii	19 33 55.49	5
	η Ophiuchi	17 1 45.68	5		Moon I.	20 4 16.22	5
	Moon I.	17 27 51.23	5		α^2 Capricorni	20 9 43.13	5
	58 Ophiuchi	17 34 25.72	5		ϱ Capricorni	20 20 17.25	5
	4 Sagittarii	17 50 37.15	5	4	γ Capricorni	21 31 45.84	5
31	58 Ophiuchi	17 34 25.63	5		Moon II.	21 50 27.27	5
	4 Sagittarii	17 50 37.25	5		ι Aquarii	21 58 19.17	5
	Moon I.	18 19 34.34	5		θ Aquarii	21 8 54.17	5
	ν' Sagittarii	18 45 5.87	5	5	ι Aquarii	21 58 19.16	5

Date, 1849.	Object.	Observed R.A.	No. Wires.	Date, 1849.	Object.	Observed R.A.	No. Wires.
		h. m. s.				h. m. s.	
Aug. 5	θ Aquarii	22 8 54.33	5	Aug. 8	μ Piscium	1 22 18.80	5
	Moon II.	22 41 48.47	5		ν Piscium	1 33 36.61	5
	λ Aquarii	22 41 46.51	5	9	μ Piscium	1 22 18.81	5
	φ Aquarii	23 6 32.55	5		ν Piscium	1 33 36.72	5
6	λ Aquarii	22 44 46.57	5		Moon II.	2 10 25.25	5
	φ Aquarii	23 6 32.37	5		ν Ceti	2 27 58.96	5
	Moon II.	23 32 57.32	5	10	ξ^2 Ceti	2 20 10.03	5
	27 Piscium	23 50 58.78	5		ν Ceti	2 27 59.06	5
	33 Piscium	23 57 38.49	5		Moon II.	3 6 27.08	5
7	27 Piscium	23 50 58.87	5	11	ξ Tauri	3 19 0.87	5
	33 Piscium	23 57 38.40	5		Moon II.	4 5 9.43	5
	Moon II.	0 24 21.07	5		α Tauri	4 27 17.01	5
	μ Piscium	0 40 53.45	5	12	γ Tauri	4 11 13.82	4
	ν Piscium	0 45 19.70	5		α Tauri	4 27 16.96	5
8	δ Piscium	0 40 53.42	5		Moon II.	5 6 32.38	5
	20 Ceti	0 45 19.56	5	14	γ Geminorum	6 29 0.04	5
	Moon II.	1 16 36.67	5		Moon II.	7 14 20.88	5

The following corresponding observations are selected from the list of observations made for the use of the Coast Survey: —

II. *Moon-Culminations observed at the Charleston Observatory by Professor* Lewis R. Gibbes, *Director.*

Date, 1849.	Object.	Observed R.A.	No. Wires.	Date, 1849.	Object.	Observed R.A.	No. Wires.
		h. m. s.				h. m. s.	
July 30	α Virginis	13 17 15.58	5	July 30	4 Sagittarii	17 50 37.23	5
	5579 B. A. C.	16 32 52.96	5	31	Moon I.	17 34 25.52	5
	η Ophiuchi	17 1 45.65	5		4 Sagittarii	17 50 36.97	5
	Moon II.	17 27 33.97	5		Moon I.	18 19 16.90	5
	58 Ophiuchi	17 34 26.03	5		ν Capricorni	18 45 5.93	5

III. *Moon-Culminations observed at Seaton Station, Washington (Coast Survey, Section III.), by* Sears C. Walker, Esq., *Assistant C. S.*

This experiment was made by Mr. Walker, with a diaphragm of 45 wires, constructed for the Coast Survey by William Wurdeman, Esq. The recording was effected mechanically by the Morse Register. The circuit-breaking apparatus was invented and constructed for the Coast Survey, by Joseph Saxton, Esq.

Date, 1849.	Object.	Observed R.A.	No. Wires.	Date, 1849.	Object.	Observed R.A.	No. Wires.
		h. m. s.				h. m. s.	
Aug. 4	γ Capricorni	21 31 45.769	45	Aug. 4	θ Aquarii	22 8 50.296	45
	Moon II.	21 49 45.471	45				

IV. *Moon-Culminations observed at Harvard Observatory, Cambridge, Mass., by* William Cranch Bond, Esq., *Director.*

Date, 1849.	Object.	App. R.A.	Date, 1849.	Object.	App. R.A.
		h. m. s.			h. m. s.
July 27	Moon I.	14 56 17.69	Aug. 1	e^2 Sagittarii	19 33 55.55
	β Libræ	15 8 55.00	2	Moon I.	20 2 42.80
	ο Serpentis	15 36 51.84		α^2 Capricorni	20 9 43.05
	β Scorpii	15 56 41.80		ϱ Capricorni	20 20 17.27
	δ Ophiuchi	16 6 28.24	3	α^2 Capricorni	20 9 43.03
Aug. 1	β Scorpii	15 56 41.83		ϱ Capricorni	20 20 16.98
	δ Ophiuchi	16 6 28.08		Moon I.	20 54 58.73
	Moon I.	19 10 16.00		Moon II.	20 57 8.38
	λ Sagittarii	18 18 41.83		i Capricorni	21 13 52.57
	γ' Sagittarii	18 45 5.88		γ Capricorni	21 31 45.31
	ϱ' Sagittarii	19 22 57.47			

In addition to the observations made for the Coast Survey, Mr. **Walker** has extracted the following from Nos. 704 and 715 of the *Astronomical Notices* of the late Privy Councillor **Schumacher**.

V. *Moon-Culminations observed at Hamburg, by* Charles Rümker, *Director.*

Date, 1849.	Object.	App R A. h. m. s.	Date, 1849	Object.	App R A. h. m. s.
July 31	4 Sagittarii	17 50 37.179	July 31	λ Sagittarii	18 18 41.973
	Moon I.	18 6 18.273		ν Sagittarii	18 45 5.980

VI. *Moon-Culminations observed at Leipzig by* Dr. D'Arrest, *Director.*

Date, 1849.	Object.	App. R A. h. m. s.	No. Wires.	Date, 1849.	Object.	App. R A. h. m. s.	No. Wires.
Aug. 5	ι Aquarii	21 58 19.14	5	Aug. 7	27 Aquarii	23 50 58.76	5
	θ Aquarii	22 8 51.33	5		33 Piscium	23 57 38.63	5
	Moon II.	22 28 23.93	5		Moon II.	0 10 50.81	5
	λ Aquarii	22 44 46.51	5		δ Piscium	0 40 53.24	5
	φ Aquarii	23 6 32.36	5		20 Ceti	0 45 19.73	5

From these data Mr. **Walker** has computed the following values for the longitude of the Sand Key Station.

		Longitude of Sand Key. h. m. s.
By Moon I. with Cambridge,	July 30	5 27 38.97
Charleston,	31	5 27 50.14
Hamburg,	—	5 27 40.02
Cambridge,	Aug. 1	5 27 36.57
"	2	5 27 16.90
Mean by Moon I., ...		5 27 36.52
By Moon II. with Seaton Station, Aug. 4		5 27 27.39
Mean by both limbs, ...		5 27 31.96

Mr. **Walker**, from a comparison of the computations of **De Ferrer**, **Wurm**, and **Oltman**, finds for the longitude of the Moro Castle, in Havana, 5h. 29m. 28s. west of Greenwich. Professor J. H. C. **Coffin**, U. S. N., from **De Ferrer**'s last computations, finds 5h. 29m. 27s.5. Captain **Talcott**, U. S. T. E., from 23 moon-culminations, compared with corresponding observations at Greenwich and Edinburgh in 1839, found for the longitude of the Balize, 5h. 56m. 20s. Professor **Coffin**, by two series of chronometric comparisons of these two points in 1843, found for the longitude of the Custom-House at Key West 5h. 27m. 14s.5.

Mr. **Hilgard**, from Professor **Coffin**'s longitude of the Key West Custom-House, finds, by the geodetic reduction to Sand Key Station, the longitude of 5h. 27m. 31s.5. From this result and that of the moon-culminations, the longitude of Sand Key provisionally adopted is 5h. 27m. 31s.73 west of Greenwich. This is the best available result at present, the telegraph lines not having yet reached this section.

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On the Orbit of the Great Comet of 1843, by Professor J. S. Hubbard.
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Eunomia.
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THE

ASTRONOMICAL JOURNAL.

No. 33.

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ELEMENTS OF EGERIA, AND COMPARISON WITH OBSERVATIONS IN 1850-51.

By PROFESSOR J. S. HUBBARD,

OF THE WASHINGTON OBSERVATORY.

As the number of the asteroids increases, the necessity for a systematic division of labor in the computation of their motions becomes more and more urgent, and, following the example of one or two other computers, I have selected one of the new planets, *Egeria*, with the intention of making from year to year such calculations as may be necessary respecting it. The elements I have already given in No. 25 of this Journal (Vol. II. p. 4) enabled me to reduce all the observations that could be collected, and to form the following normals: —

M. T. Greenwich.	α	δ	No. Obs.
1850, Nov. 12.0	27° 56′ 27″.4	+ 8° 16′ 19″.1	6
1851, Feb. 3.0	30 7 42.3	+16 40 1.5	7
April 27.0	63 14 46.1	+28 36 12.8	4

In making the comparisons with Elements I., it appeared that the Neapolitan observations differed from those made at other places, seeming to require a constant correction of about —36″ in α, and of —16″ in δ. As the source of the error was not to be found in the computations, I have not employed these observations in the subsequent work, but have only given below the results of their comparison with Elements II.

From the above normals, I computed the following orbit: —

Elements II.

1851, January 1.0, M. T. Greenwich.

M	299° 2′ 4″.05	
☊	43 17 9.90	M. Equinox, 1851.0
π	119 4 56.37	
i	16 33 2.00	
φ	4 51 45.508	
μ	14 18.3060	

For the middle observation, these elements give,

$$d\lambda = +0''.15 \qquad \text{C.} - \text{O.} \qquad d\beta = +0''.05$$

and the ephemeris based on the orbit gives for the three normals,

	C. — O. $d\alpha$	$d\delta$
Nov. 12.0	—0″.1	—0″.1
Feb. 3.0	+0.4	+0.1
April 27.0	—0.1	+0.1

The following table contains all the observations I have been able to collect, and the results of comparison with Elements II. The times have been corrected for aberration, and the places for parallax, as usual.

1850, M. T. Greenwich.	α	δ	C. — O. $\Delta\alpha$	$\Delta\delta$	Place.	Authority.
Nov. 2.245279	30° 31′ 46″.1	+7° 58′ 58″.3	—33″.6	—25″.7	Naples,	A. N., XXXI. p. 347
3.258176	30 14 54.7	8 0 21.7	30.9	17.6	Naples,	" " 347
4.268843	29 58 17.2	8 2 2.0	32.6	22.5	Naples,	" " 347
5.257750	29 42 31.9	8 3 37.0	56.8	20.2	Naples,	" " 347
7.270221	29 9 35.1	8 7 2.0	22.9	14.1	Naples,	" " 347
8.288415	28 53 49.5	8 9 1.6	42.8	19.9	Naples,	" " 347
9.389258	28 36 32.3	8 10 54.6	34.6	— 4.4	Naples,	" " 347
.400455	35 52.2	10 49.5	4.9	+ 2.1	Rome, Merid.,	" " 358
10.281157	28 22 51.8	8 12 47.8	—35.4	— 9.1	Naples,	" " 347
.396981	20 11.1	12 56.1	+19.5	3.0	Rome, Merid.,	" " 358
12.402052	27 50 27.5	8 17 14.3	+ 4.3	1.6	London,	Comptes Rendus, XXXI. p. 729
13.520268	27 34 17.9		— 0.6		Altona,	A. N., XXXI. p. 335
.522783		8 19 47.2		— 0.2	Altona,	" " 335
14.259620	27 23 43.4	8 21 32.2	+ 1.7	0.0	London,	Comptes Rendus, XXXI. p. 729
.488447	20 29.4	22 1.9	+ 2.1	+ 3.5	Hamburg,	A. N., XXXI. p. 359
15.267389	27 9 40.7	+8 24 5.6	— 1.2	— 4.7	Hamburg,	" " 359

1850, M. T. Greenwich.	α	δ	C. — O.		Place.	Authority.
			Δα	Δδ		
Nov. 15.272817	27 10′ 4″.0	+8 24′ 7″.7	—29″.0	— 6″.1	Naples,	A. N., XXXII. p. 79
.386774	7 52.5	24 25 5	+ 8.1	6.7	Hamburg, Merid.,	“ XXXI. 359
.445051		24 28.8		1.2	Altona,	“ “ 335
.447729	7 10.8		— 0.6		Altona,	“ “ 335
16.255078	26 56 6.4	8 26 32.1	+ 3.1	0.2	Hamburg,	“ “ 359
.289599	56 26.0	26 53.7	—44.5	—16.4	Naples,	“ XXXII. 79
(¹) .405455	54 5.5	26 55.3	+ 2.3	+ 0.1	Liverpool,	Monthly Notices, R. A. S., XI. p. 2
20.355055	26 3 31.3	8 37 52.1	+ 8.5	+ 6.4	Hamburg,	A. N., XXXI. p. 359
21.307609	25 52 23.4		— 3.2		Vienna,	“ “ 353
.334694		8 40 57.1		0.0	Vienna,	“ “ 353
(²) .347208	52 17.5	41 15.9	—25.1	—16.4	Naples,	“ XXXII. 79
.405595	51 12.7	41 8.4	— 1.2	+ 1.9	Durham,	Monthly Notices, XI. p. 126
.410886	51 6.9	41 10.3	+ 0.9	1.0	Liverpool,	“ “ “ 2
.488594	50 16.8	41 25.0	— 3.4	+ 0.7	Cambridge, Eng.,	“ “ “ 34
(³) 22.278196	25 41 41.6	8 43 58.1	35.5	— 3.5	Naples,	A. N., XXXII. p. 79
(⁴) 23.232683	25 30 31.6	8 47 3.7	— 1.1	4.2	Vienna,	“ “ 68
.342358	29 13.8	47 26.0	+ 4.7	4.9	Vienna, Merid.,	“ “ 68
.348238	29 13.2	47 22.7	+ 1.5	— 0.5	Liverpool,	Monthly Notices, XI. p. 2
.387451	28 50.2	47 29.7	— 1.2	+ 0.3	Cambridge, Eng., Merid.	“ “ “ 33
24.222170	25 19 49.5	8 50 14.6	+ 1.8	2.5	Berlin,	A. N., XXXI. p. 380
25.321352	25 8 26.1	8 54 1.5	2.7	+ 2.1	Berlin,	“ “ 380
.353119	8 2.7	54 15.1	7.1	— 4.8	Hamburg,	“ “ 359
.380942	7 48.9		4.0		Cambridge, Eng., Merid.	Monthly Notices, XI. p. 33
.432746	7 17.7	54 31.7	3.9	4.7	Cambridge, Eng.,	“ “ “ 34
26.253859	24 59 10.2	8 57 22.1	+ 3.6	0.5	Hamburg,	A. N., XXXI. p. 359
(⁵) .269076	59 37.2	57 48.1	—32.3	—23.5	Naples,	“ XXXII. 79
.299818	58 43.2	57 29.0	+ 3.8	+ 2.5	Berlin,	“ XXXI. 380
.350369	58 16.9	57 52.4	0.2	—10.0	Hamburg, Merid.	“ “ 359
27.335984	24 48 56.4	9 1 19.8	0.3	— 1.7	Liverpool,	Monthly Notices, XI. p. 33
.505443	47 19.2	1 52.0	3.6	+ 3.8	Durham,	“ “ “ 126
28.221217	24 40 51.1	9 4 34.0	3.0	+ 3.1	Hamburg,	A. N., XXXI. p. 359
.371317		5 22.8		—11.5	Cambridge, Eng., Merid.	Monthly Notices, XI p. 33
.442175	38 56.1	5 28.3	0.7	0.8	Liverpool,	“ “ “ 33
.455189	38 47.7	5 31.7	+ 2.2	1.2	Durham,	“ “ “ 126
.475897	38 40.0	5 35.5	— 1.0	— 0.3	Berlin,	A. N., XXXI. p. 380
29.335303	24 31 12.1	9 8 53.0	+ 3.5	+ 1.5	Hamburg,	“ “ 359
.349002	31 8.5	8 59.2	0.2	— 1.5	Liverpool,	Monthly Notices, XI. p. 33
.368145	30 58.3	9 16.8	+ 0.7	—14.6	Cambridge, Eng., Merid.	“ “ “ 33
.383238	30 52.0	9 5.7	— 0.6	+ 0.1	Berlin,	A. N., XXXI. p. 380
30.244526	24 23 40.9	9 12 46.6	+ 6.7	—16.1	Hamburg,	“ “ 359
Dec. 3.331993	24 1 18.2	9 25 21.9	— 7.8	+ 1.2	Bonn,	“ XXXII. 62
4.269779	23 55 21.3	9 29 31.8	—15.2	— 2.1	Bonn,	“ “ 62
5.343008	23 48 44.2	9 34 15.6	+ 0.9	+ 3.3	Liverpool,	Monthly Notices, XI. p. 33
.441768	48 3.0	34 54.2	+ 8.4	— 8.3	Cambridge, Eng.,	“ “ “ 34
6.306556	23 43 25.8	9 38 42.6	+ 1.4	+ 2.4	Liverpool,	“ “ “ 33
.354031	43 13.5	39 1.3	— 1.7	— 3.1	Durham,	“ “ “ 126
.443602	42 56.6	39 12.0	3.1	+ 2.9	Bonn,	A. N., XXXII. p. 62
7.343476	23 38 30.0		15.8		Cambridge, Eng., Merid.	Monthly Notices, XI. p. 33
8.467838	23 33 9.7	9 49 7.8	3.0	— 4.2	Durham,	“ “ “ 126
9.268136	23 29 52 5	9 52 58.6	3.0	+ 1.5	Liverpool,	“ “ “ 33
.334994	29 35.2	53 21.7	1.4	— 1.7	Berlin,	A. N., XXXI. p. 380
.376548	29 26.1	53 31.3	2.3	+ 1.1	Durham,	Monthly Notices, XI. p. 126
10.287402	23 26 10.0	9 58 13.6	6.1	— 6.5	Bonn,	A. N., XXXII. p. 62
.327709	25 56.6	58 22.1	— 1.1	3.0	Berlin,	“ XXXI. 380
11.278632	23 22 51.0	10 3 20.8	+ 0.8	— 8.8	Bonn,	“ XXXII. 62
.446453	22 20.1	4 0.5	1.8	+ 3.7	Liverpool,	Monthly Notices, XI. p. 33
12.359670	23 19 45.9	10 8 46.3	6.6	+ 5.2	Durham,	“ “ “ 126
13.466973	23 17 19.2	10 14 47.4	+ 2.9	— 0.7	Liverpool,	“ “ “ 33
16.309955	23 13 38.7	+10 30 33.2	—11.8	— 0.9	Hamburg,	A. N., XXXII. p. 106

(¹) In the *Monthly Notices*, XI. p. 2, line 7, for $34^s.38$, read $24^s.38$.

(²) In *A. N.*, XXXII. p. 79, line 17, for 26° 52′ 17″.7, read 25° 52′ 17″.7.

(³) In *A. N.*, XXXII. p. 79, line 18, for 26° 41′ 46″.5, read 25° 41′ 46″.5.

(⁴) In *A. N.*, XXXII p. 68, line 3, for 8° 46′ 0″.3, read 8° 47′ 0″.3.

(⁵) In *A. N.*, XXXII. p. 79, line 19, for 26° 59′ 39″.0, read 24° 59′ 39″.0.

1850, M. T. Greenwich.	α	δ	C. — O.		Place.	Authority.
			Δα	Δδ		
Dec. 16.357087	23° 13′ 23″.2	+10° 30′ 47″.4	+ 1″.6	+ 1″.0	Berlin,	A. N., XXXI. p. 380
17.201275	23 13 12.6	10 35 38.7	—15.1	0.0	Hamburg,	" XXXII. 106
.360108	12 55.4	36 32.1	1.0	1.6	Berlin,	" " 215
19.311158	23 13 12.0	10 48 2.3	— 0.8	0.1	Liverpool,	Monthly Notices, XI. p. 33
.493063	13 17.4	49 5.6	+ 0.4	2.1	Durham,	" " " 126
20.305712	23 14 1.7	10 53 57.5	— 3.9	+ 4.2	Berlin,	A. N., XXXII. p. 215
.343305	13 57.2	54 17.5	+ 2.9	— 2.1	Durham,	Monthly Notices, XI. p. 126
21.272313		10 59 55.2		+ 1.1	Bonn,	A. N., XXXII. p. 62
.275010	23 15 14.1		— 6.3		Bonn,	" " 62
.386333	15 17.7	11 0 37.6	0.4	+ 0.9	Liverpool,	Monthly Notices, XI. p. 33
.439892	15 22.5	0 58.9	— 0.4	— 0.6	Durham,	" " " 126
23.391079	23 19 0.9	11 13 12.5	+ 2.7	— 0.8	Durham,	" " " 126
24.522120	23 21 58.7	11 20 25.3	— 2.6	+ 1.1	Washington,	A. J., II. p. 19
26.247574	23 27 27.4	11 31 41.7	7.2	0 9	Hamburg,	A. N., XXXII. p. 106
.283658	27 37.4	31 50.4	— 9.6	6.5	Berlin,	" " 215
.331999	27 36.7	32 15.1	+ 1.3	1.0	Durham,	Monthly Notices, XI. p. 126
.364315	28 1.7	32 25.0	—16.9	3.9	Padua,	A. N., XXXII. p. 79
.492025	28 12.1	33 15.0	0.0	+ 4.6	Washington,	A. J., II. p. 19
27.237891	23 31 10.2	11 38 24.5	—10.7	— 6.7	Padua,	A. N., XXXII. p. 79
.360871	31 28.1	38 46.5	+ 0.1	+20.7	Vienna,	" " 68
.404987	31 38.1	39 18.9	0.5	6.0	Durham,	Monthly Notices, XI. p. 126
.464026	31 51.2	39 41.1	+ 1.5	7.6	Washington,	A. J., II. p. 19
28.355844	23 35 40.2	11 45 37.4	— 4.8	12.5	Padua,	A. N., XXXII. p. 79
.416232	35 49.3	46 9.0	+ 1.8	5.5	Durham,	Monthly Notices, XI. p. 126
29.287224	23 39 49.6	11 52 5.7	— 1.4	5.8	Padua,	A. N., XXXII. p. 79
30.246736	23 44 37.0	11 58 46.0	6.7	3.3	Berlin,	" " 215
.305128	44 49.7	58 35.7	1.5	38.0	Vienna,	" " 68
.328261	45 1.7	59 17.8	— 6.4	5.5	Padua,	" " 79
31.256278	23 49 49.6	12 5 49.3	+ 1.1	3.4	Hamburg,	" " 106
.393670	50 39.4	6 46.3	— 3.2	4.4	Berlin,	" " 215
1851.						
Jan. 1.481542	23 56 54.5	12 14 29.9	2.7	3.2	Washington,	A. J., II. p. 19
5.315694	24 22 37.2	12 42 21.3	— 6.7	6.7	Berlin,	A. N., XXXII. p. 215
7.477416	24 39 19.4	12 58 40.9	+ 2.6	0.8	Washington,	A J , II. p. 19
11.468569	25 14 47.5	13 29 30.5	1.8	0.6	Washington,	" " 19
12.460953	25 24 22.5	13 37 19.7	+ 6.3	1.1	Washington,	" " 19
13.283768	25 32 45.0	13 43 49.1	— 0.7	+ 3.8	Berlin,	A. N., XXXII. p. 215
.468326	31 29.3	45 21.5	+ 7.9	— 0.2	Washington,	A. J., II. p. 19
14.286374	25 43 4.9	13 51 53.3	0.9	+ 0.9	Berlin,	A. N., XXXII. p. 215
.476858	44 57.7	53 25.2	8.5	0.9	Washington,	A. J., II. p. 19
15.227098	25 53 0.4	13 59 24.3	6.5	4.8	Berlin,	A. N., XXXII. p. 215
16.461784	26 6 36.7	14 9 24.8	4.7	+ 6.0	Washington,	A. J., II. p. 19
(1) 22.295568	27 17 4.4	14 58 8.5	4.8	— 7.0	Hamburg,	A. N., XXXII. p. 106
24.519161	27 46 32.4	15 16 57.3	6.8	+ 0.5	Washington,	A. J., II. p. 19
25.516983	28 0 12.7	15 25 28.0	8.4	3 8	Washington,	" " 19
27.315596	28 25 43.5	15 41 2.3	0.8	3 0	Berlin,	A. N., XXXII. p. 215
(2) 28.258614	28 39 20.6	15 49 13.2	+ 3.7	+ 4.7	Hamburg,	" " 106
.330061	40 32.4	49 56 7	— 5.4	— 1 3	Berlin,	" " 215
31.288756	29 24 56.6	16 16 5.5	— 0.2	—10.1	Hamburg,	" " 106
(3) .535879	28 43.1	18 2.6	+ 2.5	+ 3.9	Washington,	A. J., II. p. 19
Feb. 1.262820	29 40 11.1	16 24 39.3	— 6.5	— 6.1	Hamburg,	A. N., XXXII. p. 106
.322892	41 2.0	25 7.5	0.9	— 2.3	Berlin,	" " 215
5.283683	30 45 12.8	17 0 27.9	— 2.5	+ 2.7	Berlin,	" " 215
6.312044	31 2 16.3	17 9 35.2	+11.0	11.9	Hamburg,	" " 106
.605178	7 27.3	12 24.5	— 1.6	1.5	Washington,	A. J., II. p. 19
7.563569	31 23 46.2	17 20 57.8	+ 3.8	8.7	Washington,	" " 19
8.327715	31 36 54 0	+17 27 59.2	+10.0	+ 3.3	Liverpool,	Monthly Notices, XI. p. 125

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(1) In the *Monthly Notices*, XI p. 59, and in *A. N.*, XXXII. p. 91, is an observation made at Markree Castle, January 18, which agrees very well with the ephemeris employed, but not with the true place of the planet. Mr. FERGUSON, who has been so kind as to examine that region of the heavens, finds a small star in $\alpha = 1^{h.}\ 42^{m.}\ 46^{s.}.3$, $\delta = 13°\ 47'.0$, which is probably the object then observed for *Egeria*.

(2) In *A. N.*, XXXII. p 106, line 9, for 28° 29′ 19″.6, read 28° 39′ 19″.6.

(3) In *A. J.*, II. p. 19, line —10, for $7^{h.}\ 3^{m.}\ 21^{s.}.9$, read $8^{h.}\ 3^{m.}\ 21^{s.}.9$.

1851, M. T. Greenwich.	α	δ	C. — O. $\varDelta\alpha$	C. — O. $\varDelta\delta$	Place.	Authority.
(1) Feb. 11.538662	32° 31′ 2″.6	+17° 57′ 20″.7	+ 5″.9	— 1″.7	Washington,	A. J., II. p. 19
(1) 12.542409	32 52 15.6	18 6 29.5	12.0	+ 1.0	Washington,	" " 19
13.283548	33 6 6.8	18 13 17.1	0.9	+ 1.7	Berlin,	A. N., XXXII. p. 215
16.544020	34 7 37.5	18 43 26.7	2.0	— 8.2	Washington,	A. J., II. p. 19
17.343878	34 23 2.5	18 50 35.1	3.2	+ 6.2	Berlin,	A. N., XXXII. p. 215
.563221	27 14.9	52 50.6	6.3	— 7.9	Washington,	A. J., II. p. 19
21.302798	35 41 25.8	19 27 20.4	1.6	— 3.1	Hamburg,	A. N., XXXII. p. 133
22.543923	36 6 35.3	19 38 46.5	+ 4.9	+ 0.7	Washington,	A. J., II. p. 19
23.268166	36 21 36.3	19 45 36.0	— 4.9	— 6.2	Hamburg,	A. N., XXXII. p. 133
.334632	22 45.4	46 4.5	+ 8.1	+ 2.2	Liverpool,	Monthly Notices, XI. p. 125
.338115	22 53.0	46 7.8	+ 4.8	0.9	Berlin,	A. N., XXXII. p. 215
24.310584	36 43 5.6	19 55 6.3	— 0.4	+ 3.1	Hamburg,	" " 133
.340768	43 35.7	55 27.8	+ 7.2	— 1.6	Berlin,	" " 215
26.315574	37 25 5.4	20 13 39.1	4.5	+ 5.2	Hamburg,	" " 133
.518757	29 16.5	15 29.2	+11.8	8.0	Washington,	A. J., II. p. 19
27.287397	37 45 55.8	20 22 41.9	— 5.6	2.7	Berlin,	A. N., XXXII. p. 215
.293146	45 49.7	22 40.2	+ 7.9	7.6	Hamburg,	" " 133
28.340305	38 8 26.1	20 32 28.5	0.1	1.3	Berlin,	" " 215
Mar. 1.552660	38 34 40.6	20 43 42.6	+ 2.4	+ 0.7	Washington,	A. J., II. p. 20
2.285921	38 50 46.6	20 50 37.8	— 1.9	— 7.4	Hamburg,	A. N., XXXII. p. 133
.547649	56 27.9	52 58.2	+ 1.4	2.6	Washington,	A. J., II. p. 20
3.371149	39 14 30.6	21 0 34.6	8.2	2.2	Liverpool,	Monthly Notices, XI. p. 125
.563897	18 46.2	2 21.3	8.6	— 2.0	Washington,	A. J., II. p. 20
4.590400	39 41 35.7	21 11 46.1	9.6	+ 1.9	Washington,	" " 20
10.532456	41 57 24.9	22 6 25.3	12.6	— 0.1	Washington,	" " 20
11.554548	42 21 27.0	22 15 48.8	9.3	— 3.6	Washington,	" " 20
13.531933	43 8 23.1	22 33 44.9	+ 5.9	+ 0.1	Washington,	" " 20
21.564551	46 25 34.1	23 45 51.1	—12.0	— 1.8	Washington,	" " 20
25.533978	48 6 13.4	24 20 45.9	+ 8.5	4.9	Washington,	" " 20
26.512238	48 31 25.0	24 29 15.6	12.4	4.6	Washington,	" " 20
(2) 28.512504	49 23 36.9	24 46 28.2	5.9	1.1	Washington,	" " 20
April 6.522110	53 25 29.1	26 2 0.0	1.6	— 0.1	Washington,	" " 20
9.536406	54 48 51.6	26 26 9.8	+ 2.6	+11.4	Washington,	" " 20
11.528577	55 41 53.4	26 42 9.5	—12.4	+ 0.4	Washington,	" " 20
(3) 18.527088	59 4 35.9	27 35 53.2	+ 1.8	— 6.4	Washington,	" " 20
22.531336	61 1 39.6	28 5 6.2	6.3	— 7.3	Washington,	" " 20
23.540665	61 31 31.0	28 12 6.9	+ 4.9	+ 3.0	Washington,	" " 20
29.537778	64 31 28.2	28 53 22.2	— 7.6	— 5.4	Washington,	" " 20
May 1.529214	65 31 42.4		+13.8		Washington,	" " 20
2.539115	66 2 53.7	+29 12 44.7	— 3.8	+ 2.4	Washington,	" " 20

The following normals, deduced from the above table, may be considered as embodying the results of the observations during this first appearance of *Egeria*.

Date.	α		δ		C. — O. $\varDelta\alpha$	C. — O. $\varDelta\delta$
1850, Nov. 22.0	25° 44′ 17″.0	±0″.438	+ 8° 43′ 3″.3	±0″.509	+2″.20	—1″.62
Dec. 20.0	23 13 43.6	±0.546	10 52 9.5	±0.423	—2.80	+1.22
1851, Jan. 17.0	26 12 42.7	±0.686	14 13 53.5	±0.639	+2.66	+1.37
Feb. 14.0	33 19 23.9	±0.717	18 19 51.9	±0.700	+3.34	+1.26
Mar. 14.0	43 19 35.1	±1.255	22 38 2.0	±0.480	+5.45	—2.12
April 19.0	59 18 20.8	±1.754	+27 39 17.5	±1.469	+0.80	—0.25

(1) "The assumed place of the star of comparison, as given in *A. J.*, II. p. 20, was derived solely from LALANDE. An observation in α by Mr. LOCKE, and in δ by Professor BENEDICT, gives for the mean place 1850.0, $\alpha = 2^{h.}\ 9^{m.}\ 27^{s.}.90$, $\delta = +17° 45' 25''.77$, which values have been adopted above. In *A. J.*, II. p. 19, line —7, for $-0^{m.}\ 45^{s.}.65$, read $+0^{m.}\ 45^{s.}.65$."

(2) In *A. J.*, II. p. 20, line 14, for $9^{h.}\ 34^{m.}\ 39^{s.}.4$, read $7^{h.}\ 34^{m.}\ 39^{s.}.4$. (3) In *A. J.*, II. p. 20, line 19, for 27° 36′ 51″.74, read 27° 35′ 51″.74.

OBSERVATIONS OF EUNOMIA,

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By Mr. JAMES FERGUSON.

[Communicated by Lieutenant Maury.]

[Corrected for refraction.]

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	⚵ — * Δα	⚵ — * Δδ	⚵'s apparent α	⚵'s apparent δ	A.
1851.	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″	
Sept. 1	9 44 18.6	4	6161 B. A. C.	+6 35.05	+ 4 14.62	18 9 14.69	—23 39 12.94	10
	9 51 56.0	9	*A*	+0 41.62	— 1 5.72	9 14.92	23 39 11.34	10
2	7 39 9.6	9	*A*	+0 58.92	+ 2 20.71	9 32.30	23 35 45.74	10
4	8 42 51.6	7	*A*	+1 43.22	+10 1.71	10 16.77	23 28 4.00	10
	8 44 49.2	6	33684 Lalande	—0 36.62	— 5 56.24	10 16.26	23 28 8.53	10
16	8 54 55.5	7	6222 B. A. C.	+3 47.34	+13 32.31	16 50.92	22 45 38.84	9
18	8 34 16.0	10	*a*	—1 16.10	+16 9.97	18 11.33	22 38 16.02	8
20	8 6 46.1	10	*b*	+1 1.83	+15 4.77	19 41.35	22 31 24.92	10
21	8 14 3.2	10	*c*	+1 15.05	+ 2 3.14	20 28.00	22 27 58.13	10
	8 9 32.2	5	34222 Lalande	—3 4.85	— 4 15.29	18 20 28.19	22 27 49.76	10
. . .	. . .		. . . . .	. . .	. . . .	. . . .	. . . .	
Oct. 27	7 9 58.1	12	6550 B. A. C.	+0 5.60	—13 6.56	19 1 7.29	—20 15 11.48	10

Adopted Mean Places, 1850.0, *of Comparison-Stars.*

*	Mag.	α	δ	Authority.	No. of Comp.
		h. m. s.	° ′ ″		
6161 B. A. C.	6	18 2 34.1	—23 43 31.1	British Association Catalogue.	
A	9	18 8 27.73	23 38 10.0	Washington Equatorial, from 6161.	5
33684 Lalande	8.9	18 10 47.36	23 22 16.87	Lalande's Catalogue.	
6222 B. A. C.	7	18 12 58.28	22 59 16.0	British Association Catalogue.	
6266 B. A. C.	7	18 19 1.19	23 5 18.2	" " "	
a	8.9	18 19 21.97	22 54 31.64	Washington Equatorial, from 6266.	6
b	9	18 20 37.83	22 46 36.53	" " from *a*.	9
c	9	18 19 8.70	22 30 6.99	" " from *b*.	9
34222 Lalande.	9	18 23 27.79	22 23 40.77	Lalande's Catalogue.	
6550 B. A. C.	7	19 0 57.10	—20 2 15.8	British Association Catalogue.	

NEW COMET.

The following circular has been received from Dr. Petersen, announcing the discovery of another comet.

Altona, 1851, *October* 26.

Late yesterday evening, I received a letter from Mr. Brorsen, in Senftenberg, with the intelligence that he had discovered on the 22d inst., just before 8 o'clock, in the constellation of the Hunting Dogs, a new comet with a shining nucleus and a bright tail of more than a degree in length, and resembling in appearance Hind's comet of 1847. According to a simple estimation, its position at about $8^{h.}$ $3^{m.}$ mean Senftenberg time was, $\alpha = 13^{h.}\ 39^{m.}.4$, $\delta = +32°\ 35'.5$.

"P. S. — This morning I have obtained the following roughly reduced comparison of the comet with the Bessel star, Zone 414, $\alpha = 13^{h.}\ 43^{m.}\ 18^{s.}.1$, $\delta = +33°\ 15'\ 43''$.

1851.	M. T. Senftenberg.	☄ α	☄ δ
	h. m. s.	h. m. s.	° ′ ″
Oct. 22	17 17 13.5	13 42 1.3	+32 50 6
Daily motion,		+6 16.6	+ 1 16.3

The comet has two tails; the smaller, as in Bessel's drawing, is turned towards the sun."

A. C. PETERSEN.

LETTER FROM WILLIAM LASSELL, ESQ., TO THE EDITOR.

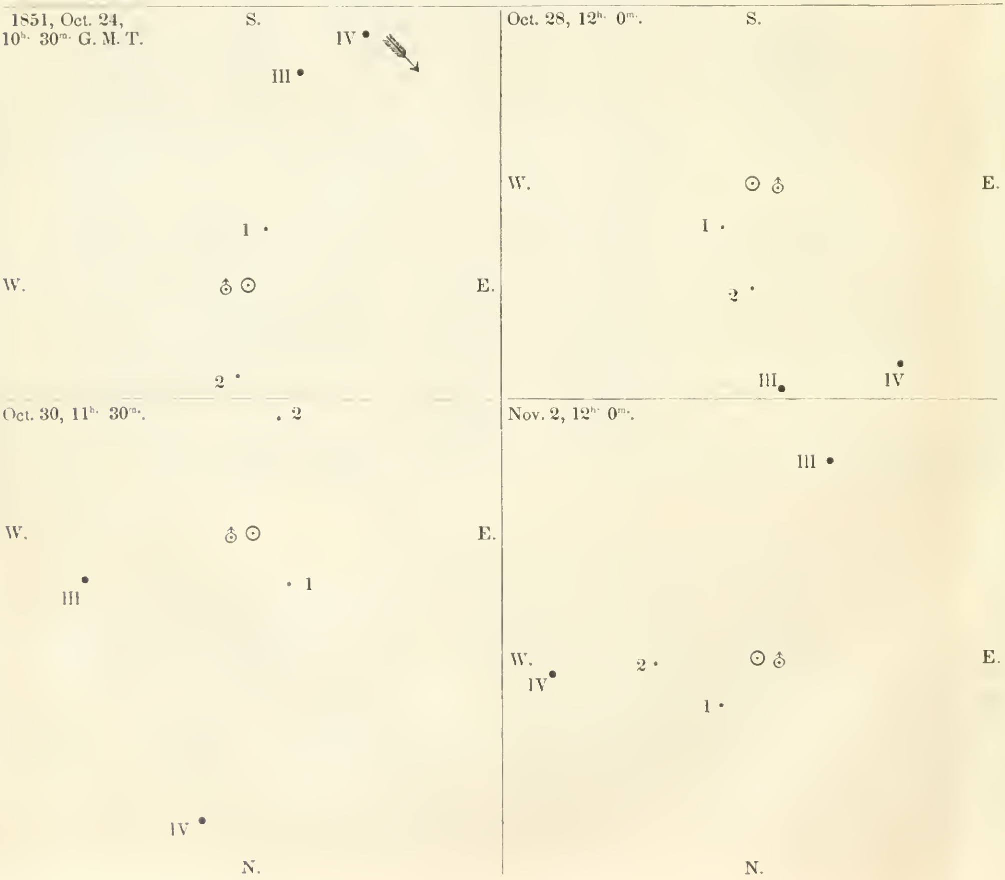
Starfield, *Liverpool*, 1851, *November* 11.

Will you permit me to announce through your journal my discovery of two new satellites of the planet *Uranus*. They are interior to the two bright satellites first discovered by Sir William Herschel, and usually known as the second and fourth. It would appear that they are also interior to Sir William's *first* satellite, to which he assigned a period of revolution of about five days and twenty-one hours, but which satellite I have hitherto failed to recognize.

I first saw these two satellites of which I now announce the discovery on the 24th of last month, and had then a strong impression that they would prove to be attendants of the planet. I obtained further observations of them on the 28th and 30th of October, and on the 2d instant; and I found that all the observations were well satisfied, for so short an interval, by a period of revolution of four days for the outermost, and two days and five tenths for the innermost.

They are most minute objects, having probably much less than half the brightness of the second and fourth, though on the 2d instant the whole four appeared at once in my telescope charged with a power of 778 times. I inclose diagrams of the configurations of the satellites, as they appeared on each of the four nights above mentioned. The large dots III. and IV. are the two bright satellites, from which the positions and distances of the new ones were generally estimated or measured.

Diagrams of the Satellites of Uranus.



ON THE CORRECTIONS TO BE APPLIED TO THE COÖRDINATES OF THE SUN AS GIVEN IN THE BRITISH NAUTICAL ALMANAC.

By DR. WILLIAM CHARLES GOETZE.

The coördinates of the sun X, Y, Z, given in the *British Nautical Almanac*, under the title "Sun's Coördinates," are not the true coördinates of the sun, as they were probably intended to be, but still affected in a certain sense by aberration, and also by the neglect of the sun's latitude, having been computed by the formulas,

$$\begin{aligned} X &= R \cos \odot \\ Y &= R \sin \odot \cos \omega \\ Z &= R \sin \odot \sin \omega \end{aligned}$$

where R is the radius-vector of the sun affected by aberration,* $\odot$ the sun's true longitude, and ω the apparent obliquity of the ecliptic. Now the strict formulas should be,

$$\begin{aligned} X' &= R' \cos \odot \cos B \\ Y' &= R' (\sin \odot \cos B \cos \omega - \sin B \sin \omega) \\ Z' &= R' (\sin \odot \cos B \sin \omega + \sin B \cos \omega) \end{aligned}$$

where R' denotes the true radius-vector of the sun, $\odot$ the sun's true longitude, B the sun's latitude, and ω the apparent obliquity of the ecliptic. Now let $R' = R + \delta R$, then δR will evidently be the effect of aberration in R, or in other words the increment in R, due to the aberration time (equation of light), $497''.235\ R$; then, by making

$$\frac{497''.235}{86400''\,.\,\mu} = \theta$$

where μ is the modulus of Briggs's logarithmic system $= 0.4342945$, and remembering at the same time that B is an excessively small quantity, we shall have,

$$\log.\ \theta = 8.12226 - 10$$

and

$$\begin{aligned} \Delta X &= X' - X = \theta R X\,.\,\delta \log.\ \text{Brigg.}\ R \\ \Delta Y &= Y' - Y = \theta R Y\,.\,\delta \log.\ \text{Brigg.}\ R - R \sin \omega \sin 1''\,.\,B \\ \Delta Z &= Z' - Z = \theta R Z\,.\,\delta \log.\ \text{Brigg.}\ R + R \cos \omega \sin 1''\,.\,B \end{aligned}$$

where δ log. Brigg. R denotes the daily variation of the log. radius-vector of the sun, and B is expressed in seconds of arc; both these quantities may be immediately obtained from the *Nautical Almanac*, or any other astronomical ephemeris, with perfect accuracy.

Now, by making

$$\left.\begin{aligned} \delta X &= \theta R X\,.\,\delta \log.\ \text{Brigg.}\ R \\ \delta Y &= \theta R Y\,.\,\delta \log.\ \text{Brigg.}\ R \\ \delta Z &= \theta R Z\,.\,\delta \log.\ \text{Brigg.}\ R \end{aligned}\right\} \text{terms depending on the effect of aberration in sun's radius-vector,}$$

and

$$\left.\begin{aligned} y &= R \sin \omega \sin 1''\,.\,B \\ z &= R \cos \omega \sin 1''\,.\,B \end{aligned}\right\} \text{terms depending on sun's latitude,}$$

we shall finally have the following values for the sun's true coördinates, viz.:

$$\begin{aligned} X' &= X + \Delta X &&= X + \delta X \\ Y' &= Y + \Delta Y &&= Y + \delta Y - y \\ Z' &= Z + \Delta Z &&= Z + \delta Z + z \end{aligned}$$

where the total corrections to be applied to the coördinates of the sun as given in the *Nautical Almanac*, in order to obtain true coördinates, are denoted by ΔX, ΔY, ΔZ.

The Table I. at the end of this paper, containing the quantities δX, δY, δZ, expressed in units of the seventh decimal place, was specially calculated by me for the year 1850, and for every successive day of that year at Greenwich mean noon, but as the elements of the earth's orbit change very slowly, it will also be available for any other year whatever, at least for a very long series of years. The arrangement of this table is so simple, that it hardly requires any explanation; a few examples will, however, be given farther on, which will tend to give the necessary information.

The factors $R \sin \omega \sin 1''$, and $R \cos \omega \sin 1''$, which occur in the expressions y and z, depending on the sun's latitude, are nearly constant quantities, and may be found for the middle of each month in any year, expressed in units of the seventh decimal place, by inspecting the following table.

Table containing the Factors $R \sin \omega \sin 1''$, *and* $R \cos \omega \sin 1''$.

For the 15th of	$R \sin \omega \sin 1''$.	$R \cos \omega \sin 1''$.	For the 15th of
January,	19.0	43.8	December,
February,	19.1	43.9	November,
March,	19.2	44.3	October,
April,	19.4	44.7	September,
May,	19.5	45.0	August,
June,	19.6	45.2	July.

By means of this small table, the Table II., immediately succeeding Table I. at the end of this paper, was formed. This table will furnish the corrections y and z due to any latitude of the sun, for any date in any year, by mere inspection; and with respect to signs it may be proper to mention, that the sign of the correction y is always contrary to that of the sun's latitude, and the sign of z the same as that of the sun's latitude.

A few examples will suffice to illustrate the use of Tables I. and II. Let it be required, for instance, to find the true coördinates of the sun for the 17th of August, 1851, at Greenwich mean noon, from the *Nautical Almanac*. On inspecting that work for 1851, at page 144 it will be found that the sun's latitude for 1851, August 17, was $= B = -0''.73$, and at page 247, the erroneous coördinates X, Y, and Z may be obtained as follows:—

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* The reason why the radius-vector of the sun is given in the *Nautical Almanac* as affected by aberration is unknown to me, as this quantity is only used in computations, and can from its nature never be compared in a direct manner with observation. The same remark applies also, though perhaps not so fully, to the sun's longitude, which is also given in the *Nautical Almanac* as affected by aberration.

Erroneous coördinate	$X = -0.8180719$	$Y = +0.5465160$	$Z = +0.2371520$
By Table I. we have	$\delta X = +10$	$\delta Y = -6$	$\delta Z = -3$
And by Table II. with	$B = \cdot \cdot \cdot \cdot \cdot$	$y = +14$	$z = -33$
True coördinates	$X' = -0.8180709$	$Y' = +0.5465168$	$Z' = +0.2371483$

In a similar manner we obtain for 1848, November 7, when B will be found $= -0''.24$:

$X = -0.6970927$	$Y = -0.6451426$	$Z = -0.2799334$
$\delta X = +10$	$\delta Y = +8$	$\delta Z = +4$
	$y = +5$	$z = -11$
$X = -0.6970917$	$Y' = -0.6451413$	$Z = -0.2799341$

And in the same way we shall find for 1850, April 27, that $B = +0''.69$, and also,

$X = +0.8060404$	$Y = +0.5540888$	$Z = +0.2404293$
$\delta X = +12$	$\delta Y = +8$	$\delta Z = +4$
	$y = -14$	$z = +31$
$X' = +0.8060416$	$Y' = +0.5540882$	$Z = +0.2404328$

which examples will sufficiently tend to illustrate the use of Tables I. and II. at the end of this paper.

I further take the liberty of subjoining the values of the effect of aberration on R, and log. Brigg. R, as these may be serviceable for correcting the log. radius-vector of sun in the *Nautical Almanac*. The following small table contains these values for every tenth day in any year expressed in units of the seventh decimal place.

Date.	δR.	δ log. R.	Date.	δR.	δ log. R.	Date.	δR.	δ log. R.
Jan. 1	+1	+0	May 11	+13	+5	Sept. 18	−16	−7
Jan. 11	+2	+1	May 21	+10	+4	Sept. 28	−16	−7
Jan. 21	+6	+2	May 31	+9	+4	Oct. 8	−17	−7
Jan. 31	+9	+4	June 10	+6	+3	Oct. 18	−16	−7
Feb. 10	+11	+5	June 20	+3	+1	Oct. 28	−15	−6
Feb. 20	+13	+6	June 30	+1	+0	Nov. 7	−13	−6
March 2	+15	+6	July 10	−2	−1	Nov. 17	−12	−5
March 12	+16	+7	July 20	−5	−2	Nov. 27	−9	−4
March 22	+16	+7	July 30	−7	−3	Dec. 7	−7	−3
April 1	+17	+7	Aug. 9	−10	−4	Dec. 17	−4	−2
April 11	+16	+7	Aug. 19	−12	−5	Dec. 27	−1	−0
April 21	+15	+7	Aug. 29	−14	−6	Dec. 32	+1	+0
May 1	+15	+6	Sept. 8	−15	−7			

The above corrections are to be added algebraically to the respective values of the *Nautical Almanac*, in order to obtain true ones.

Permit me, at the same time, to make the following addendum to section six of my paper in the *Ergänzungs-heft* to the *Astronomische Nachrichten*, through the medium of your journal.

The angles M and Q under Number 18 in section six of that paper are to be determined in the following manner, in order to avoid ambiguity : —

1. When the heliocentric motion is direct,

Take $\frac{1}{2}(M + Q)$ and $\frac{1}{2}(M - Q)$ in the same quadrants.

2. When the heliocentric motion is retrograde,

Take $\frac{1}{2}(M + Q)$ and $\frac{1}{2}(M - Q)$ in reverse quadrants.

3. Then sin WD will always be positive, and therefore the arc WD always $< 180°$.

(*To be continued.*)

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By DR. WILLIAM CHARLES GOETZE.

(*Continued from page 72.*)

TABLE I.

Containing the Corrections to be applied to the Sun's Coördinates on Account of Aberration in Sun's Radius-Vector.

Date.	January.			February.			March.			April.			May.			June.			Date.
	δx	δy	δz	δx	δy	δz	δx	δy	δz	δx	δy	δz	δx	δy	δz	δx	δy	δz	
1	+0	—0	—0	+6	—6	—3	+14	—4	—2	+17	+3	+1	+11	+9	+4	+3	+8	+3	1
2	0	0	0	6	6	3	14	4	2	17	3	1	11	9	4	3	7	3	2
3	0	0	0	7	6	3	14	4	2	17	3	1	10	9	4	2	7	3	3
4	0	1	0	7	6	3	14	4	2	16	4	1	10	9	4	2	7	3	4
5	+0	—1	—0	+7	—6	—3	+14	—3	—2	+16	+4	+1	+10	+9	+4	+2	+7	+3	5
6	+1	—1	—1	+7	—6	—3	+14	—3	—2	+16	+4	+2	+10	+9	+4	+2	+6	+2	6
7	1	1	1	7	6	3	15	3	2	16	4	2	9	9	4	2	6	2	7
8	1	1	1	8	6	3	15	3	1	16	4	2	9	9	4	1	6	2	8
9	1	2	1	8	6	3	15	3	1	15	5	2	9	9	4	1	5	2	9
10	+1	—2	—1	+8	—6	—3	+15	—2	—1	+15	+5	+2	+8	+9	+4	+1	+5	+2	10
11	+1	—2	—1	+8	—6	—3	+15	—2	—1	+15	+5	+2	+8	+9	+4	+1	+5	+2	11
12	1	2	1	9	6	3	15	2	1	15	5	2	8	9	4	1	5	2	12
13	1	2	1	9	6	3	15	2	1	15	5	2	7	9	4	1	4	2	13
14	2	3	1	9	6	3	15	2	1	14	6	2	7	9	4	1	4	2	14
15	+2	—3	—1	+10	—6	—3	+15	—1	—1	+14	+6	+2	+7	+9	+4	+1	+4	+2	15
16	+2	—3	—2	+10	—5	—2	+15	—1	—1	+14	+6	+3	+7	+9	+4	+0	+4	+1	16
17	2	3	2	10	5	2	16	1	1	14	6	3	6	8	4	0	4	1	17
18	2	3	2	10	5	2	16	1	+0	14	6	3	6	8	4	0	3	1	18
19	3	4	2	11	5	2	16	1	0	13	7	3	6	8	4	0	3	1	19
20	+3	—4	—2	+11	—5	—2	+16	+0	+0	+13	+7	+3	+5	+8	+4	+0	+3	+1	20
21	+3	—4	—2	+11	—5	—2	+16	+0	+0	+13	+7	+3	+5	+8	+4	+0	+3	+1	21
22	3	4	2	12	5	2	16	0	0	13	7	3	5	8	4	0	3	1	22
23	4	4	2	12	5	2	16	0	0	13	7	3	5	8	4	0	2	1	23
24	4	5	2	12	5	2	16	1	0	12	8	3	4	8	4	0	2	1	24
25	+4	—5	—2	+13	—5	—2	+16	+1	+0	+12	+8	+3	+4	+8	+4	+0	+2	+1	25
26	+5	—5	—3	+13	—4	—2	+16	+1	+0	+12	+8	+1	+4	+8	+4	+0	+2	+0	26
27	5	5	3	13	4	2	17	2	1	12	8	4	4	8	3	0	2	0	27
28	5	5	3	13	4	2	17	2	1	12	8	4	4	8	3	0	1	0	28
29	5	6	3	14	4	2	17	2	1	11	9	4	3	8	3	0	1	0	29
30	+6	—6	—3	+14	—4	—2	+17	+2	+1	+11	+9	+4	+3	+8	+3	+0	+1	+0	30
31	+6	—6	—3	+14	—4	—2	+17	+3	+1	+11	+9	+4	+3	+8	+3	+0	+1	+0	31

Date.	July.			August.			September.			October.			November.			December.			Date.
	δ x	δ y	δ z	δ x	δ y	δ z	δ x	δ y	δ z	δ x	δ y	δ z	δ x	δ y	δ z	δ x	δ y	δ z	
1	+0	+1	+0	+5	—5	—2	+13	—5	—2	+16	+2	+1	+11	+8	+3	+3	+7	+3	1
2	0	0	0	5	6	2	13	5	2	16	2	1	11	8	4	3	7	3	2
3	0	0	0	6	6	2	14	5	2	16	3	2	11	8	4	3	6	3	3
4	0	+0	+0	6	6	2	14	4	2	16	3	2	11	8	4	3	6	3	4
5	+1	—1	—1	+6	—6	—3	+14	—4	—2	+16	+3	+2	+10	+8	+4	+2	+6	+3	5
6	+1	—1	—1	+7	—6	—3	+14	—4	—2	+16	+3	+2	+10	+8	+4	+2	+6	+3	6
7	1	1	1	7	7	3	15	4	2	16	4	2	10	8	4	2	6	3	7
8	1	1	1	8	7	3	15	4	2	16	4	2	10	8	4	2	6	3	8
9	1	2	1	8	7	3	15	4	2	16	4	2	9	8	4	2	6	3	9
10	+1	—2	—1	+8	—7	—3	+15	—3	—2	+16	+4	+2	+9	+8	+4	+1	+5	+3	10
11	+1	—2	—1	+8	—7	—3	+15	—3	—2	+16	+5	+2	+9	+8	+4	+1	+5	+3	11
12	1	2	1	9	7	3	15	3	2	16	5	2	9	9	4	1	5	3	12
13	1	3	1	9	7	3	16	3	2	16	5	3	8	9	4	1	5	2	13
14	1	3	1	9	7	3	16	2	1	15	5	3	8	9	4	1	5	2	14
15	+2	—3	—2	+9	—6	—3	+16	—2	—1	+15	+5	+3	+8	+9	+4	+0	+4	+2	15
16	+2	—3	—2	+9	—6	—3	+16	—2	—1	+15	+6	+3	+7	+9	+4	+0	+4	+2	16
17	2	3	2	10	6	3	16	1	1	15	6	3	7	9	4	0	4	2	17
18	2	4	2	10	6	3	16	1	1	15	6	3	7	9	4	0	4	2	18
19	2	4	2	10	6	3	16	1	1	15	6	3	6	9	4	0	3	2	19
20	+2	—4	—2	+10	—6	—3	+16	—1	—1	+14	+6	+3	+6	+8	+4	+0	+3	+1	20
21	+2	—4	—2	+10	—6	—3	+16	+0	+0	+14	+7	+3	+6	+8	+4	+0	+3	+1	21
22	2	4	2	11	6	3	16	0	0	14	7	3	6	8	4	0	3	1	22
23	3	4	2	11	6	3	16	0	0	14	7	3	5	8	3	0	2	1	23
24	3	4	2	11	6	3	16	0	0	13	7	3	5	8	3	0	2	1	24
25	+3	—5	—2	+11	—5	—2	+16	+0	+0	+13	+7	+3	+5	+7	+3	+0	+2	+0	25
26	+3	—5	—2	+11	—5	—2	+16	+1	+1	+13	+8	+3	+4	+7	+3	+0	+1	+0	26
27	3	5	2	12	5	2	16	1	1	12	8	3	4	7	3	0	1	0	27
28	4	5	2	12	5	2	16	1	1	12	8	3	4	7	3	0	1	0	28
29	4	5	2	12	5	2	16	1	1	12	8	3	4	7	3	0	1	0	29
30	+4	—5	—2	+12	—5	—2	+16	+2	+1	+12	+8	+3	+3	+7	+3	+0	+0	+0	30
31	+4	—5	—2	+13	—5	—2	+16	+2	+1	+11	+8	+3	+3	+7	+3	+0	+0	+0	31

Argument: Day of the Month.

TABLE II.

Containing the Corrections to be applied to the Sun's Coördinates on account of Sun's Latitude = B.

± B	January 15.0.		February 15.0.		March 15.0.		April 15.0.		May 15.0.		June 15.0.		± B
	∓ y	± z	∓ y	± z	∓ y	± z	∓ y	± z	∓ y	± z	∓ y	± z	
0″.00	0	0	0	0	0	0	0	0	0	0	0	0	0″.00
0.02	0	1	0	1	0	1	0	1	0	1	0	1	0.02
0.04	1	2	1	2	1	2	1	2	1	2	1	2	0.04
0.06	1	3	1	2	1	2	1	2	1	3	1	3	0.06
0.08	2	4	2	3	2	3	2	3	2	4	2	4	0.08
0.10	2	4	2	4	2	4	2	4	2	5	2	5	0.10
0.12	2	5	2	5	2	5	2	5	2	6	2	6	0.12
0.14	3	6	3	6	3	6	3	6	3	7	3	7	0.14
0.16	3	7	3	7	3	7	3	7	3	7	3	7	0.16
0.18	4	8	4	8	4	8	4	8	4	8	4	8	0.18
± B	∓ y	± z	∓ y	± z	∓ y	± z	∓ y	± z	∓ y	± z	∓ y	± z	± B
	December 15.0.		November 15.0.		October 15.0.		September 15.0.		August 15.0.		July 15.0.		

$\pm B$	January 15.0.		February 15.0.		March 15.0.		April 15.0.		May 15.0.		June 15.0.		$\pm B$
	$\mp y$	$\pm z$	$\mp y$	$\pm z$	$\mp y$	$\pm z$	$\mp y$	$\pm z$	$\mp y$	$\pm z$	$\mp y$	$\pm z$	
0.″20	4	9	4	9	4	9	4	9	4	9	4	9	0.″20
0.22	4	10	4	10	4	10	4	10	4	10	4	10	0.22
0.24	5	11	5	11	5	11	5	11	5	11	5	11	0.24
0.26	5	11	5	11	5	11	5	11	5	12	5	12	0.26
0.28	6	12	6	12	6	12	6	12	6	13	6	13	0.28
0.30	6	13	6	13	6	13	6	13	6	14	6	14	0.30
0.32	6	14	6	14	6	14	6	14	6	15	6	15	0.32
0.34	7	15	7	15	7	15	7	15	7	16	7	16	0.34
0.36	7	16	7	16	7	16	7	16	7	16	7	16	0.36
0.38	8	17	8	17	8	17	8	17	8	17	8	17	0.38
0.40	8	18	8	18	8	18	8	18	8	18	8	18	0.40
0.42	8	19	8	19	8	19	8	19	8	19	8	19	0.42
0.44	9	20	9	20	9	20	9	20	9	20	9	20	0.44
0.46	9	20	9	20	9	20	9	20	9	21	9	21	0.46
0.48	10	21	10	21	10	21	10	21	10	22	10	22	0.48
0.50	10	22	10	22	10	22	10	22	10	23	10	23	0.50
0.52	10	23	10	23	10	23	10	23	10	24	10	24	0.52
0.54	10	24	10	24	11	24	11	24	11	25	11	25	0.54
0.56	11	24	11	24	11	25	11	25	11	25	11	25	0.56
0.58	11	25	11	25	12	26	12	26	12	26	12	26	0.58
0.60	11	26	11	26	12	27	12	27	12	27	12	27	0.60
0.62	11	27	11	27	12	28	12	28	12	28	12	28	0.62
0.64	12	28	12	28	12	29	13	29	13	29	13	29	0.64
0.66	12	29	12	29	13	29	13	29	13	30	13	30	0.66
0.68	13	30	13	30	13	30	14	30	14	31	14	31	0.68
0.70	13	31	13	31	13	31	14	31	14	32	14	32	0.70
0.72	13	32	13	32	13	32	14	32	14	33	14	33	0.72
0.74	14	33	14	33	14	33	15	33	15	34	15	34	0.74
0.76	14	33	14	33	14	33	15	34	15	34	15	34	0.76
0.78	15	34	15	34	15	34	16	35	16	35	16	35	0.78
0.80	15	35	15	35	15	35	16	36	16	36	16	36	0.80
0.82	15	36	15	36	15	36	16	37	16	37	16	37	0.82
0.84	16	37	16	37	16	37	16	38	17	38	17	38	0.84
0.86	16	37	16	38	16	38	17	38	17	39	17	39	0.86
0.88	17	38	17	39	17	39	17	39	18	40	18	40	0.88
0.90	17	39	17	40	17	40	17	40	18	41	18	41	0.90
0.92	17	40	17	41	17	41	17	41	18	42	18	42	0.92
0.94	18	41	18	42	18	42	18	42	19	43	19	43	0.94
0.96	18	42	18	42	18	42	18	43	19	43	19	43	0.96
0.98	19	43	19	43	19	43	19	44	20	44	20	44	0.98
1.00	19	44	19	44	19	44	19	45	20	45	20	45	1.00
1.02	19	45	19	45	20	45	20	46	20	46	20	46	1.02
1.04	20	46	20	46	20	46	20	46	20	47	20	47	1.04
1.06	20	46	20	47	20	47	21	47	21	48	21	48	1.06
1.08	21	47	21	47	21	48	21	48	21	49	21	49	1.08
1.10	21	48	21	48	21	49	21	49	21	50	22	50	1.10
1.12	21	49	21	49	22	50	22	50	22	50	22	51	1.12
1.14	22	50	22	50	22	51	22	51	22	51	22	52	1.14
1.16	22	51	22	51	22	51	23	52	23	52	23	52	1.16
1.18	22	52	23	52	23	52	23	53	23	53	23	53	1.18
1.20	23	53	23	53	23	53	23	54	23	54	24	54	1.20
$\pm B$	$\mp y$	$\pm z$	$\mp y$	$\pm z$	$\mp y$	$\pm z$	$\mp y$	$\pm z$	$\mp y$	$\pm z$	$\mp y$	$\pm z$	$\pm B$
	December 15.0.		November 15.0.		October 15.0.		September 15.0.		August 15.0.		July 15.0.		

Arguments: Sun's latitude $= B$, and approximate date.

OBSERVATIONS OF IRENE,

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By Mr. JAMES FERGUSON.

[Communicated by Lieutenant Maury.]

[Corrected for refraction.]

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	Irene — Star		Irene's apparent		A.
				Δα	Δδ	α	δ	.
1851.	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″	
June 9	10 39 45.0	8	Weisse XV. 864	—0 35.46	+ 6 11.00	15 44 22.83	—14 9 49.48	10
	11 56 23.8	11	" 864	—0 37.93	+ 6 3.62	44 20.36	9 48.85	10
			" 845	+0 41.21	+ 1 10.52	44 20.95	9 55.46	10
(1) 10	9 53 20.0	4	" 845	—0 0.98	— 1 34.72	43 38.67	12 40.56	10
	10 24 38.3	2	" 864	—1 20.85	+ 3 12.68	43 37.53	12 39.77	10
	10 29 1.6	5	" 845	—0 2.59	— 1 40.90	43 37.06	12 46.79	10
	10 56 50.0	10	" 845	—0 3.30	— 1 44.77	43 36.35	12 50.68	10
13	10 11 13.1	13	" 792	—0 1.41	— 0 14.28	41 26.49	22 12.16	9
	10 58 11.0	10	" 792	—0 2.87	— 0 20.28	41 25.03	22 18.16	9
14	10 13 38.5	6	" 792	—0 41.65	— 3 33.03	40 47.26	25 30.92	10
	12 18 3.0	10	" 792	—0 45.69	— 3 51.03	40 43.23	25 48.92	10
15	11 29 16.6	14	" 792	—1 23.85	— 7 8.16	40 5.08	29 6.03	9
16	10 2 59.1	1	" 792	—1 58.82	—10 24.85	39 29.09	32 22.71	9
17	10 8 11.7	12	" 744	+0 6.02	+10 18.08	38 52.55	35 50.84	7
	10 37 29.1	10	" 744	+0 5.31	+10 13.43	38 51.85	35 55.50	8
	10 52 29.3	2	" 744	—0 5.14	+10 11.02	38 51.67	35 57.90	8
18	10 23 27.9	6	" 744	—0 28.89	+ 6 41.06	38 17.65	39 27.91	8
	10 48 16.0	10	" 744	—0 29.55	+ 6 37.10	38 16.99	39 31.90	8
19	10 25 11.0	6	" 744	—1 1.94	+ 2 58.89	37 44.60	14 43 10.11	10
24	10 15 19.6	2	" 637	+2 3.96	+ 1 55.17	35 24.12	15 2 37.60	9
		2	" 644	+1 42.73	+ 2 28.87	35 24.48	2 37.94	9
25	9 28 37.6	2	" 637	+0 41.99	— 2 2.40	35 2.12	6 35 00	6
July 2	9 15 12.6	6	B. A. C. 5184	—1 14.85	— 5 13.73	33 10.47	37 12.35	8
	10 10 11.1	7	"	—1 15.16	— 5 22.56	33 10.16	37 21.18	8
4	10 16 0.6	14	"	—1 31.08	—14 41.69	32 54.13	46 40.27	10
5	9 12 13.7	10	*a*	+0 14.92	— 4 43.06	32 49.43	15 51 14.90	10
13	10 43 52.6	12	Lalande 28617	—2 22.90	— 7 50.84	33 8.79	16 31 24.04	10
17	9 50 47.6	12	*c*	+0 15.37	+ 1 14.69	33 59.70	16 52 19.83	10
20	10 40 29.0	7	Lalande 28453	+4 39.69	+ 1 26.55	34 54.66	17 8 46.70	10
21	9 29 26.4	4	" 28453	+5 0.94	— 3 47.50	35 16.01	13 56.96	8
	9 51 42.1	10	*d*	+0 38.41	— 1 4.04	35 15.76	14 3.56	8
22	9 14 39.8	12	*d*	+1 0.87	— 6 29.38	35 38.21	19 29.23	9
25	10 25 31.1	10	Lalande 28726	—1 53.73	+ 0 47.09	36 57.29	36 31.56	9
28	8 41 18.6	10	"	—0 23.18	—16 2.81	38 27.79	17 53 21.41	10
Aug. 1	8 51 42.0	18	Lalande 28766	+0 12.56	— 1 48.47	40 47.86	18 16 19.22	8
3	8 53 15.6	9	" 28766	+1 31.55	—13 26.87	42 6.82	27 57.73	8
3		9	" 28838	—0 52.43	+ 1 1.88	42 6.33	27 53.81	8
6	9 49 14.5	10	B. A. C. 5264	—2 9.04	+10 37.78	44 16.49	18 45 38.85	10
12	8 12 25.6	7	Lalande 29043	—1 25.87	+ 9 26.64	49 4.18	19 20 42.58	7
		7	" 29044	—1 26.70	+ 9 41.48	49 4.22	20 42.58	7
13	8 18 43.9	10	" 29043	—0 33.26	+ 3 34.98	49 56.83	26 35.24	8
		10	" 29044	—0 34.06	+ 3 48.68	49 56.89	26 35.38	8
14	8 34 45.1	11	" 29044	+0 20.00	— 2 9.92	50 51.04	32 33.98	9
15	8 49 20.2	6	" 29043	+1 16.48	— 8 20.55	51 46.59	38 30.71	10
		6	" 29044	+1 15.69	— 8 7.59	51 46.66	38 31.59	10
16	8 25 3.8	4	Gr. 12 Y. C. 1315	—1 48.07	—18 59.64	52 41.33	44 17.26	9
	8 30 28.6	6	Lalande 29044	+2 10.66	—13 55.09	15 52 41.56	19 44 19.07	9
26	7 58 10.0	5	B. A. C. 5395	—1 59.72	+18 20.15	16 2 56.04	—20 42 36.60	10

(1) Observed distance and angle of position.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	Irene — Star		Irene's apparent		A.
				Δ α	Δ δ	α	δ	
1851.	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″	
Aug. 27	7 58 56.1	6	B. A. C. 5395	—0 52.93	+12 39.19	16 4 3.84	—20 48 17.54	10
		7	*e*	—1 40.80	— 4 46.37	4 4.00	48 7.74	9
28	7 59 27.7	3	B. A. C. 5395	+0 15.08	+ 6 59.24	5 11.79	53 57.46	9
		3	*e*	—0 32.59	—10 29.52	5 12.20	53 51.68	9
29	8 20 17.3	6	B. A. C. 5395	+1 25.77	+ 1 7.01	6 22.47	20 59 49.68	10
30	9 20 17.6	2	“	+2 39.08	— 4 39.43	7 35.76	21 5 36.09	10
31	8 22 24.3	8	*f*	—1 9.30	+ 2 14.31	8 43.43	11 8.15	10
Sept. 3	8 3 7.6	2	*f*	+2 28.26	—14 17.39	12 21.18	27 40.02	10
	8 3 25.0	14	*g*	+0 25.23	+ 0 51.13	12 21.01	27 37.36	10
4	7 39 28.0	5	*g*	+1 35.13	— 4 38.63	13 30.91	21 33 6.93	10
18	7 29 17.1	3	Lalande 30207	+2 51.22	—13 44.70	32 16.60	22 46 48.07	8
	7 23 0.8	2	B. A. C. 5598	—2 36.91	+ 3 40.63	32 16.90	46 48.58	8
20	7 13 59.6	10	“	+0 13.84	— 6 9.61	35 7.92	56 38.75	10
	7 15 40.2	9	B. A. C. 5606	—1 4.63	— 2 40.45	35 7.87	22 56 39.56	10
21	7 12 42.4	10	“ 5598	+1 40.70	—11 0.30	36 31.46	23 1 29.31	10
		10	“ 5606	+0 22.23	— 7 29.14	36 34.76	1 28.23	10
24	7 16 33.7	4	“ 5680	—4 51.87	— 0 6.84	41 0 82	15 48.75	10
25	7 13 26.3	5	“	—3 22.77	— 4 43.67	42 29.16	20 25.60	10
26	7 12 16.7	10	“	—1 52.62	— 9 14.99	43 59.41	24 57.09	10
Oct. 1	7 16 6.8	2	B. A. C. 5730	—2 48.36	+14 16.71	51 39.15	47 13.48	10
3	6 53 42.9	3	*i*	+0 18.84	+ 5 50.45	54 46.32	23 55 39.69	5
6	7 0 47.7	3	*i*	+5 5.28	— 6 15.68	59 32.72	24 7 45.77	8
		3	B. A. C. 5752	+4 7.84	— 6 6.60	16 59 31.85	7 43.76	8
7	6 41 55.7	5	*i*	+0 55.68	— 1 54.60	17 1 7.47	11 42.50	10
8	7 10 30.3	2	*i*	+2 34.48	— 5 43.80	2 46.21	15 31.66	9
10	6 47 57.2	3	B. A. C. 5829	—2 57.03	—16 1.68	5 59.30	23 1.61	10
		3	“ 5827	—2 57.38	—15 48.89	5 59.22	22 57.21	10
11	6 39 12.6	6	“ 5829	—1 19.37	—19 35.88	7 36.95	26 35.78	10
		6	“ 5827	—1 19.57	—19 28.27	7 37.02	26 36.56	10
13	6 41 48.4	6	“ 5846	—1 40.01	+11 19.94	10 54.42	33 41.18	10
		6	“ 5851	—1 58.19	+17 0.26	10 54.47	33 40.25	10
14	6 39 1.6	2	“ 5851	—0 18.82	+13 32.82	12 33.82	36 59.58	10
15	6 33 55.4	6	“ 5851	+1 20.79	+10 14.08	14 13.42	40 26.39	10
		6	“ 5846	+1 38.99	+ 4 30.21	14 13.37	24 40 30.98	10
23	6 35 43.9	3	*l*	—0 50.25	—22 39.81	27 48.49	25 4 52.66	8
24	6 21 51.8	3	Lalande 32045	+0 45.06	—15 24.49	29 29.52	7 27.45	8
27	6 27 50.8	4	“ 32418	—3 48.98	— 7 37.67	34 41.41	15 12.63	8
31	6 15 40.8	4	“ 32559	—0 56.28	+19 6.44	17 41 45.79	—25 24 22.11	9

Adopted Mean Places for 1850.0, *of Comparison-Stars.*

*	Mag.	α	δ	Authority.	No. of Obs.
		h. m. s.	° ′ ″		
Weisse XV. 864	8	15 41 53.28	—14 15 40.45	Weisse's Catalogue.	
“ 845	9	43 34.61	10 53.76	“ “	
“ 792	9	41 23.81	21 45.56	“ “	
“ 744	8	38 41.43	14 45 56.27	“ “	
“ 637	9	33 15.08	15 4 19.58	“ “	
“ 644	9	33 36.67	4 53.66	“ “	
B. A. C. 5184	7	31 20.25	31 45 6	British Association Catalogue.	
a	9.3	32 29.47	15 46 18.62	Washington Equatorial.	6
Lalande 28617	7	35 26.78	16 23 20.40	Lalande's Catalogue.	
c	9.5	33 39.33	16 53 21.36	Washington Equatorial, from 28617 Lalande.	5
“		33 38.81	53 20.62	“ “ from 28453 Lalande.	7
Lalande 28453	7	30 10.12	17 9 59.91	Lalande's Catalogue.	
d	9.2	31 32.36	12 46.39	Washington Equatorial.	8
Lalande 28726	8	38 46.02	17 37 5.68	Lalande's Catalogue.	
“ 28766	8	40 30.38	18 14 18.26	“ “	
“ 28838	7.8	43 0.24	28 43.54	“ “	
B. A. C. 5624	7	15 46 20.71	—18 56 4.7	British Association Catalogue.	

*	Mag.	α h. m. s.	δ ° ′ ″	Authority.	No. of Obs.
Lalande 29043	8	15 50 25.21	—19 29 58.65	Washington Equatorial, from 1315 Greenwich 12 Y. C.	
" 29041	8	50 26.07	30 12.19	" " " "	
Green. 12 Y. C. 1315	7	15 44 24.55	19 25 6.61	Greenwich 12 Year Catalogue.	
B. A. C. 5395	7	16 4 51.94	21 0 46.6	British Association Catalogue.	
e	7.8	5 40.06	20 43 12.28	δ from Washington Mural; α from Equatorial.	
f	8.9	9 48.2	21 13 13.10	δ from Zone observations of west Transit; α from Equatorial; from 5395 B. A. C.	
g	8 9	11 51.08	21 28 19.09	Equatorial from *f*.	
Lalande 30207	8	29 20.79	22 34 55.98	Lalande's Catalogue.	
B. A. C. 5598	7	34 49.14	50 22.2	British Association Catalogue.	
" 5606	7	36 7.89	22 53 52.4	" " "	
" 5680	6.7	45 47.28	23 15 36.6	" " "	
" 5730	7	51 22.90	24 1 25.4	" " "	
" 5742	7	16 55 19.48	1 32.6	" " "	
i		17 0 7.19	9 43.84	Washington Equatorial, from 5730.	
B. A. C. 5827	4.5	8 52.05	7 5.23	Greenwich 12 Year Catalogue.	
" 5829	7	8 51.78	6 56.82	δ from Greenwich 12 Y. C.; α from Equatorial.	
" 5851	3.4	12 48.10	50 37.76	Greenwich 12 Year Catalogue.	
" 5846	7	12 29.86	41 58.40	British Association Catalogue.	
Madras 1165	8	26 22.84	31 9.63	Madras Observations.	
l	9.10	28 31.64	42 11.08	Washington Equatorial, from preceding.	
Lalande 32045	8.9	28 40.84	24 52 2.83	" " from *l*.	
" 32814	8.9	38 25.88	25 7 35.96	Lalande's Catalogue.	
" 32559	8.9	17 42 37.51	—25 43 29.37	" "	

LETTER FROM MR. HIND TO THE EDITOR.

London, 1851, *November* 12.

You will remember that on your short visit to London, in August last, I mentioned to you that I had missed a small star (9.10 magnitude), which was compared with *Hygea* at Washington, on the 21st October, 1850, and that I could not satisfactorily account for this circumstance on any other supposition, than by assuming it to have been an unknown planet. In Number 31 of your excellent journal, Lieutenant Maury has announced that the original observations have been examined, and that farther evidence in favor of the planetary nature of the object has been adduced, the positions resulting from the differential observations of October 16 and 22d showing an increase in right-ascension on the latter day of $1^s.76$, which is quite beyond any probable error of observation on the part of a skilful observer, such as Mr. Ferguson has proved himself to be. Now, a mere glance at the places of the suspicious object, and of the sun at the time, will be sufficient to convince us, that, if there be a planet in the case, it could not have belonged to the prolific group between *Mars* and *Jupiter*, that its mean distance in fact must be greater than that of any known planet. But here difficulties arise; for the past four years I have constantly had this very region of the heavens under close examination, having in August, 1847, missed a small star in about R.A. $19^h\ 1^m\ 15^s$, N. P. D. 111° 56′ (1800), and being also occupied in filling in all stars to the eleventh magnitude within 3° of the ecliptic for Hour XIX. of our charts. Hence, I am at a loss to imagine how a slow-moving planet of 9.10 magnitude can have escaped me, for since August, 1847, I have never seen any suspicious body in the vicinity. If we assume (as I think we may safely do, on the further hypothesis of circular motion), that Mr. Ferguson's star would be *stationary* within a day or two before or after October 16, we shall find that a planet in this position must have a distance of more than 137, and a period of above 1600 years. Such a planet would be easily recovered, and I am convinced I must have seen it during the past summer, if it retained the same degree of brilliancy assigned by Ferguson (9.10 magnitude). So far, then, as my own search has extended, I feel able to state confidently that there is no planet hereabouts of the 9.10 magnitude, but if it be possible that *its light is subject to variation* so as to cause it to descend to the eleventh class, then I should think it necessary to institute a further examination before pronouncing an opinion upon the subject. You tell me that the Washington observers are engaged in watching the small stars about the place of the one missing, but their silence up to the present date is discouraging. The *second* observation on October 21 is not given in your journal; perhaps Lieutenant Maury may favor us with the *original comparisons* by which the star's places are determined, for I conceive it is highly desirable, in a matter of such importance, that they should be in the hands of astronomers.

J. R. HIND.

Mr. Ferguson's observations on the 21st have been published in Number 21 of this journal, and in Number 749 of the *Astronomische Nachrichten*. We understand that the search for this star has been continued at the Washington Observatory, upon the supposition that it is an exterior planet, and that the search is still in progress.

G.

FROM LETTERS OF DR. PETERSEN TO THE EDITOR.

Altona, 1851, *November* 11.

The last comet (discovered by Brorsen in Senftenberg, November 11), is already so faint, that although I was able to distinguish it a week ago last Sunday, yet I could not observe it. It has not been observed either here or in Hamburg; but the following are the few observations which I have received, and I also send you the elements and ephemeris which I have just received from G. Rümker and Vogel in Berlin.

1851.	M. T. Senftenberg.	☄ α	☄ δ		
	h. m. s	h. m. s.	° ′ ″		
Oct. 22	17 17 10.3	13 42 1.81	+32 50 0.0	5	B. Z. 414; Lal. 25499
23	6 36 40.8	13 44 52.45	33 18 58.9	8	
	17 16 43.5	13 47 9.13	33 41 21.9	1	B. Z. 414
24	17 15 17.9	13 52 13.31	34 29 41.1	2	B. Z. 414; Lal. 25591, 25592
29	6 49 22.6	14 14 33.27	+37 36 21.8	8	B. Z. 415; Lal. 26348

	M. T. Vienna.	☄ α	☄ δ	
	h. m. s.	h. m. s.	° ′ ″	
Oct. 24	7 1 39.2	13 50 4.01	+34 9 27.5	8
28	6 50 49.5	14 9 47.40	+36 59 40.4	6

	M. T. Berlin.	☄ α	☄ δ	
	h. m. s.			
Oct. 30	7 27 34.2	214° 51′ 25″.5	+38° 10′ 9″.0	12

Adopted Places of Comparison-Stars.

		α	δ
		h. m. s.	° ′ ″
5 8	B. Z. 414; Lal. 25499	13 43 18.41	+33 15 44.3
1	B. Z. 414	13 42 3.36	33 43 15.5
2	B. Z. 414; Lal. 25591, 25592	13 46 48.08	34 31 18.9
8	B. Z. 415; Lal. 26348	14 17 13.50	+37 32 17.6
8	H. C.	13 43 55.30	
6	* 1 B. Z. 415, 416, 466 * 2 B. Z. 466		
12	214° 41′ 58″.9		+38° 10′ 9″.0

Elements computed from the observations at Senftenberg, October 22, Vienna, October 24, and Berlin, October 30, by E. Vogel and G. Rümker.

T	1851, September 30.66264, Mean Time Berlin.	
π	339° 46′ 4″	Apparent Equinox.
☊	41 38 30	
i	71 3 0	
Log. q	9.214886	
	Motion Direct.	

Ephemeris computed from these Elements for 6h. Mean Time Berlin.

Date.	☄ α	☄ δ	Log. △	Date.	☄ α	☄ δ	Log. △
	h. m. s.	° ′			h. m. s.	° ′	
Nov. 8	14 58 21	+42 10.9	0.0934	Nov. 14	15 21 40	+44 6.2	
9	15 2 23	42 31.9		15	25 22	44 23.2	
10	6 21	42 52.1		16	29 1	44 39.8	0.1365
11	10 16	43 11.6		17	32 37	44 55.9	
12	14 7	43 30.4	0.1156	18	36 10	45 11.6	
13	15 17 55	+43 48.6		19	15 39 40	+45 26.9	

Date.	☄ α	☄ δ	Log. △	Date.	☄ α	☄ δ	Log. △
	h. m. s.	° '			h. m. s.	° '	
Nov. 20	15 43 7	+45 41.9	0.1561	Nov. 27	16 6 7	+47 20.1	
21	46 32	45 56.6		28	9 16	47 33.4	0.1921
22	49 54	46 11.0		29	12 23	47 46.7	
23	53 14	46 25.2		30	15 27	47 59.8	
24	56 31	46 39.1	0.1746	Dec. 1	18 28	48 12.8	
25	15 59 45	46 52.9		2	16 21 27	+48 25.6	0.2086
26	16 2 57	+47 6.6					

1851, *November* 18.

The last comet (Brorsen's of October 22) had on the 22d October already become so faint that I was only able to distinguish it with great trouble, — and could not think of observing it. It seems to have been one of those comets whose light decreases with great rapidity as they move away from the sun (it passed its perihelion September 30), for although it was seen in Vienna with the naked eye on the 24th October, it is now so faint that we shall not probably receive any more observations of it. The latest observation which I have is one made by Luther at the Berlin Observatory.

1851.	M. T. Berlin.	☄ α	☄ δ	Comp.
	h. m. s.	° ' "	° ' "	
Nov. 11	6 38 3.2	227 44 53.5	+43 17 43.9	6

the assumed place of the comparison-star being

✱ α	✱ δ
227° 16' 24".1	+43° 9' 5".6

A. C. PETERSEN.

ON THE SYMBOLIC NOTATION OF THE ASTEROIDS,

By THE EDITOR.

As the number of the known asteroids increases, the disadvantages of a symbolic notation analogous to that hitherto in use increase much more rapidly even than the difficulty of selecting appropriate names from the classic mythology. Not only are many of the symbols proposed inefficient in suggesting the name of which they are intended to be an abbreviation; but some of them require for their delineation more artistic accomplishment than an astronomer is necessarily or generally endowed with. The symbol proposed for *Irene* (*A. J.*, II. 23), for example, has not only never appeared, but I am not aware that it has ever been actually drawn. To remedy this evil, and not to lose the unquestionable advantage connected with a system of symbols easily remembered and readily drawn, — it has been agreed upon by several astronomers in Germany, France, England, and America, to propose for adoption a more simple system for the group in question, — consisting of a circle containing the number of the asteroid in the chronological order of its discovery. This number will speedily become mnemonically associated with the asteroid itself; we thus have a symbol ready for every asteroid hereafter to be discovered, and this remarkable group are distinguished from the larger planets in the character of their notation. As this notation will hereafter be adopted in the *Astronomical Journal*, a table may at first not be unserviceable for reference.

Planet.	New Symbol.	Date of Discovery.	Old Symbol.
Ceres,	①	1801, January 1,	⚳
Pallas,	②	1802, March 28,	⚴
Juno,	③	1804, September 1,	⚵
Vesta,	④	1807, March 29,	⚶
Astræa,	⑤	1845, December 8,	⯙
Hebe,	⑥	1847, July 1,	
Iris,	⑦	" August 13,	
Flora,	⑧	" October 18,	
Metis,	⑨	1848, April 25,	
Hygea,	⑩	1849, April 12,	⯚
Parthenope,	⑪	1850, May 13,	
Clio,	⑫	" September 13,	
Egeria,	⑬	" November 2,	
Irene,	⑭	1851, May 20,	
Eunomia,	⑮	" July 29,	

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NEW ELEMENTS OF EGERIA, AND EPHEMERIS FOR 1852.

By PROFESSOR J. S. HUBBARD,
OF THE WASHINGTON OBSERVATORY.

Lieutenant Maury has communicated to me, for the *Journal*, the following observations of *Egeria* made by Mr. Ferguson since the reappearance of the planet. I have applied the corrections for aberration and parallax, and compared the resulting places with an ephemeris based on instantaneous elements derived by the application of perturbations to my Elements II. in the last number of this Journal.

1851, M. T. Greenwich.	α	δ
Nov. 26.785006	173° 30′ 45″.3	+20° 57′ 15″.7
28.848736	174 14 25.4	20 49 9.0
Dec. 1.792771	175 14 55.3	+20 38 22.7

	C. — O. $\Delta\alpha$	C. — O. $\Delta\delta$
Nov. 26	—73″.2	+41″.1
28	79.2	43.0
Dec. 1	—72.9	+46.4

Whence I have derived the following normal: —

	α	δ
1851, Nov. 29.0	174° 17′ 26″.80	+20° 48′ 36″.10

The six normals given in No. 33 of the *Astronomical Journal* (Vol. II. p. 68), and the one given above, furnished the following equations, in which the coefficient of $\Delta\mu$ has been divided by 100, and the logarithms of all the quantities substituted for the natural numbers.

	$\cos\delta\,.\,\Delta\alpha$	$\Delta_M\alpha$	$\Delta_{100\mu}\alpha$	$\Delta_\pi\alpha$	$\Delta_\omega\alpha$	$\Delta_\Omega\alpha$	$\Delta_i\alpha$
1850, Nov. 22	0.33788	0.08654	9.98626 *n*	0.38685 *n*	0.07815	0.14936	8.82637
Dec. 20	0.43930 *n*	9.99349	9.90935 *n*	0.30095 *n*	9.98318	0.06022	8.59982 *n*
1851, Jan. 17	0.41134	9.91361	9.72501 *n*	0.21583 *n*	9.89657	9.97418	9.06415 *n*
Feb. 14	0.50113	9.86893	9.34768 *n*	0.14676 *n*	9.84164	9.91252	9.22070 *n*
March 14	0.70160	9.85566	8.97694	0.08871 *n*	9.81704	9.87475	9.28967 *n*
April 19	9.85054	9.86809	9.72297	0.01253 *n*	9.81571	9.85079	9.29641 *n*
Nov. 29	1.84630 *n*	9.95008	0.54797	9.98335	9.88567	9.87920	9.74606

	$\Delta\delta$	$\Delta_M\delta$	$\Delta_{100\mu}\delta$	$\Delta_\pi\delta$	$\Delta_\omega\delta$	$\Delta_\Omega\delta$	$\Delta_i\delta$
1850, Nov. 22	0.20952 *n*	9 97556	9.77120 *n*	0.26796 *n*	9.96331	9.72502	8.95062 *n*
Dec. 20	0.08636	9.91715	9.56114 *n*	0.20062 *n*	9.89834	9.66366	8.71815
1851, Jan. 17	0.13672	9.84690	9.14371 *n*	0.11333 *n*	9.82029	9.58775	9.18491
Feb. 14	0.10037	9.77743	8.72582	0.01627 *n*	9.74228	9.50632	9.35864
March 14	0.32634 *n*	9.70537	9.30711	9.90466 *n*	9.66170	9.41110	9.46932
April 19	9.39794 *n*	9.58960	9.49239	9.71962 *n*	9.53586	9.23210	9.58209
Nov. 29	1.63849	9.79050 *n*	0.36991 *n*	9.77667 *n*	9.72453 *n*	9.67875 *n*	9.92741

Equal weights being given to all the equations, their solution furnished the following values for the corrections of Elements II., and the application of these corrections gave the following Elements III.

Elements III.

$\Delta M = +1' \, 33''.21$	M	299° 3′ 37″.26	1851, January 1.0, M. T. Greenwich.
$\Delta\Omega = - \quad 4.51$	Ω	43 17 5.39	Mean Equinox, 1851.0.
$\Delta\omega = + \quad 20.94$	ω	75 48 7.41	
$\Delta i = + \quad 2.26$	i	16 33 4.26	
$\Delta\varphi = +1 \quad 3.884$	φ	4 52 49.392	
$\Delta\mu = - \quad 0.2513$	μ	14 18.0547	

Computing with these elements the places of *Egeria* for the dates of the several normals, taking into account the effect of perturbations by *Jupiter* and *Saturn* for the last date, I obtained,

	C. — O. $\Delta\alpha$	C. — O. $\Delta\delta$
1850, Nov. 22	+3.″3	—0.″4
Dec. 20	—2.3	+0.6
1851, Jan. 17	—0.7	—0.1
1851, Feb. 14	—1.″6	0.″0
March 14	+1.1	—2.0
April 19	+0.6	+1.6
Nov. 29	—0.5	—0.9

The effect of perturbations on the elements from 1850, November 22.0, to 1851, December 5.0, and the osculating elements for the latter date are: —

	♃	♄
$\Delta M =$	—371.″52	—11.″33
$\Delta \Omega =$	+ 3.61	+ 0.14
$\Delta \omega =$	+374.18	+41.61
$\Delta i =$	+ 2.28	+ 0.17
$\Delta \varphi =$	— 39.891	— 2.124
$\Delta \mu =$	+ 0.3106	+ 0.0210
$\int d\mu =$	+ 68.89	+ 6.82

Osculating Elements, 1851, December 5.0.

M	19° 31′ 43.″58	1851, December 5.0, M. T. Greenwich.
Ω	43 17 9.14	Mean Equinox, 1851.0.
ω	75 55 3.30	
i	16 33 6.71	
φ	4 52 7.390	
μ	14 18.3861	

From these elements I have computed the following approximate ephemeris, commencing with the last date of Rümker's Ephemeris (*Astr. Nachr.*, No. 775), and extending through the period of the planet's visibility.

Mean Noon Greenwich. 1852	⑬ α h. m. s.	⑬ δ ° ′ ″	Log. △
March 1	12 9 25	+24 5 25	0.17120
2	8 26	24 9 22	
3	7 26	24 13 6	
4	6 26	24 16 37	
5	5 25	24 19 56	
6	4 23	24 23 4	
7	3 20	24 25 58	
8	2 16	24 28 38	
9	12 1 12	24 31 4	0.16875
10	0 7	24 33 14	
11	11 59 2	24 35 9	
12	57 56	24 36 49	
13	56 50	24 38 13	
14	55 43	24 39 22	
15	54 37	24 40 11	
16	53 31	24 40 50	
17	52 25	24 41 8	0.17103
18	51 19	24 41 8	
19	50 13	24 40 49	
20	49 7	24 40 13	
21	48 2	24 39 20	
22	46 57	24 38 10	
23	45 53	24 36 42	
24	44 49	24 34 57	
25	43 46	24 32 53	0.17798
26	42 44	24 30 31	
27	41 43	24 27 51	
28	40 42	24 24 53	
29	39 42	24 21 38	
30	38 43	24 18 7	
31	37 46	24 14 19	
April 1	36 50	24 10 15	
2	35 56	24 5 53	0.18916
3	35 3	24 1 15	
4	34 11	23 56 24	
5	33 20	23 51 11	
6	32 30	23 45 46	
7	11 31 42	+23 40 6	
April 8	11 30 56	+23 31 14	
9	30 12	23 28 1	
10	29 29	23 21 37	0.20357
11	28 48	23 14 58	
12	28 8	23 8 6	
13	27 29	23 1 1	
14	26 52	22 53 42	
15	26 17	22 46 11	
16	25 44	22 38 27	
17	25 13	22 30 32	
18	24 43	22 22 25	0.22134
19	24 15	22 14 6	
20	23 49	22 5 37	
21	23 25	21 56 57	
22	23 2	21 48 7	
23	22 41	21 39 7	
24	22 22	21 29 57	
25	22 4	21 20 35	
26	21 48	21 11 9	0.24076
27	21 34	21 1 32	
28	21 22	20 51 66	
29	21 12	20 41 52	
30	21 3	20 31 50	
May 1	20 56	20 21 40	
2	20 51	20 11 23	
3	20 47	20 0 59	
4	20 45	19 50 29	0.26142
5	20 45	19 39 53	
6	20 47	19 29 11	
7	20 50	19 18 23	
8	20 54	19 7 29	
9	21 0	18 56 29	
10	21 8	18 45 24	
11	21 17	18 34 13	
12	21 27	18 22 58	0.28271
13	21 39	18 11 38	
14	21 53	18 0 14	
15	11 22 8	+17 48 45	

Mean Noon Greenwich.	⑬ α	⑬ δ	Log. △	Mean Noon Greenwich.	⑬ α	⑬ δ	Log. △
1852.	h. m. s.	° ′ ″		1852	h. m. s.	° ′ ″	
May 16	11 22 25	+17 37 11		July 6	12 0 19	+6 57 6	
17	22 43	17 25 33		7	1 24	6 44 5	0.42101
18	23 2	17 13 51		8	2 30	6 31 4	
19	23 22	17 2 4		9	3 36	6 18 3	
20	23 44	16 50 14	0.30417	10	4 43	6 5 2	
21	24 7	16 38 21		11	5 50	5 52 0	
22	24 32	16 26 25		12	6 58	5 38 58	
23	24 58	16 14 26		13	8 6	5 25 56	
24	25 26	16 2 24		14	9 14	5 12 54	
25	25 55	15 50 18		15	10 23	4 59 51	0.43734
26	26 25	15 38 10		16	11 32	4 46 49	
27	26 56	15 26 0		17	12 42	4 33 46	
28	27 27	15 13 46	0.32539	18	13 53	4 20 43	
29	28 0	15 1 30		19	15 4	4 7 40	
30	28 34	14 49 13		20	16 15	3 54 38	
31	29 10	14 36 54		21	17 27	3 41 35	
June 1	29 47	14 24 32		22	18 40	3 28 32	
2	30 25	14 12 8		23	19 53	3 15 29	0.45265
3	31 4	13 59 41		24	21 7	3 2 27	
4	31 43	13 47 13		25	22 21	2 49 25	
5	32 23	13 34 43	0.34611	26	23 35	2 36 23	
6	33 4	13 22 12		27	24 49	2 23 21	
7	33 47	13 9 38		28	26 4	2 10 20	
8	34 31	12 57 3		29	27 19	1 57 19	
9	35 16	12 44 26		30	28 35	1 44 18	
10	36 2	12 31 48		31	29 51	1 31 18	0.46691
11	36 49	12 19 8		Aug. 1	31 8	1 18 18	
12	37 36	12 6 26		2	32 25	1 5 19	
13	38 23	11 53 43	0.36617	3	33 42	0 52 20	
14	39 11	11 40 59		4	34 59	0 39 21	
15	40 0	11 28 14		5	36 17	0 26 23	
16	40 51	11 15 28		6	37 35	0 13 26	
17	41 44	11 2 41		7	38 54	+0 0 29	
18	42 37	10 49 53		8	40 13	—0 12 28	0.48015
19	43 30	10 37 4		9	41 32	0 25 23	
20	44 23	10 24 13		10	42 51	0 38 17	
21	45 17	10 11 21	0.38540	11	44 11	0 51 12	
22	46 12	9 58 29		12	45 32	1 4 7	
23	47 8	9 45 36		13	46 53	1 17 2	
24	48 6	9 32 42		14	48 14	1 29 56	
25	49 4	9 19 46		15	49 35	1 42 48	
26	50 2	9 6 50		16	50 57	1 55 40	0.49236
27	51 1	8 53 54		17	52 19	2 8 30	
28	52 1	8 40 57		18	53 41	2 21 19	
29	53 1	8 28 0	0.40367	19	55 4	2 34 7	
30	54 2	8 15 2		20	56 28	2 46 55	
July 1	55 4	8 2 4		21	57 52	2 59 43	
2	56 6	7 49 5		22	12 59 16	3 12 30	
3	57 8	7 36 6		23	13 0 39	3 25 16	
4	58 11	7 23 6		24	13 2 3	—3 38 2	0.50352
5	11 59 15	+7 10 6					

TWO NEW THEOREMS, AND SOLUTION OF A PROBLEM.

By REV. THOMAS HILL.

I. *Two Theorems on the Cycloid.*

1. THE arc of a cycloid measured from the vertex, and the normal, constitute rectangular coördinates for an ellipse.

Proof. The radius of curvature being $4\,R\cos\tau$, the arc will equal its integral $4\,R\sin\tau$; and the normal, $2\,R\cos\tau$. Whence, if we put

$$x = 4\,R\sin\tau\,;\quad y = 2\,R\cos\tau$$

we shall have the equation of an ellipse,

$$\tfrac{1}{4}\, x^2 + y^2 = 4\, R^2.$$

2. The arc of a cycloid, and its ordinate, constitute rectangular coördinates for a parabola.

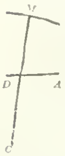
Proof. The arc and normal being as before, the ordinate is evidently $2\, R \cos^2 \iota$. Whence we have, if $2\, R \cos^2 \iota = y$,

$$\frac{x^2}{8\, R} + y = 2\, R$$

which is the equation of a parabola; y being, however, restricted from negative values, cuts the curve off through the focus.

II. *Problem in* Peirce's *Circular Coördinates.*

Let the line $C\, M$ be revolving in a plane about the point C, and let this point move in the line so that its distance, $C\, M$, from a point M, fixed in the line, will be in a constant ratio to its distance, $C\, D$, from a straight line, $A\, D$, fixed in the plane. What curve is described by M?



Solution. As the ratio $C\ D : M\ D$ is also fixed, let it be called n. $C\, M$ is by statement the radius of curvature, ϱ, and $d\, \varrho : d\, (M\, D) = C\, M : M\, D$. But taking $A\ D$ as the axis, we have

$$d\, (M\, D) = C\, D\, d\, \nu \cot \nu$$

whence we get

$$\frac{M\, D}{C M}\, d\, \varrho = \frac{C\, D}{C\, M}\, \varrho\, d\, \nu \cot \nu$$

and by division and substitution we have

$$D_\nu\, \varrho = n\, \varrho \cot \nu$$

Whence, by integration,

$$\varrho = A \sin^n \nu.$$

This equation, as I have shown in this Journal, contains the catenary; and, as is well known, contains the cycloid and parabola; three curves which, in any other coördinates than in circular, utterly refuse to be classed together.

When n is even, the curve is an oval, when odd, a series of arches. When n is large, the curve is flattened; with $n = 0$, it is reduced to a circle. With n positive, the branches or ovals are finite; with n negative, they are of infinite dimensions. With $n < 0$ and $7 - 1$, M and D are on opposite sides of m. When $n = -1$, D becomes infinitely distant. In this case, rectangular coördinates express only the alternate arches.

If the parabola, cycloid, and catenary are so interesting from their physical properties, it is possible that the other curves of the series may be of physical interest. The only point of the kind of which I am at present aware is, however, found in the fact, that when $n = 2$ the tangent of the evolute intercepted between rectangular axes will be of constant length.

ON ENCKE'S COMET.

By E. SCHUBERT.

For many years I have, in my leisure hours, occupied myself with speculating on the rotation of the planets, the results of which I think I shall publish at a future time. Some weeks ago those speculations induced me to examine the consequence of the different attractions by the sun of the different parts in a comet (consisting of separate particles grouped round a common center of gravity), and especially in Encke's Comet, as the distance from the sun in its perihelion is so small that the difference of attraction (between the parts nearest and remotest from the sun) must be considerable. The consequence of this will be an elongation of the comet in the direction toward the sun, and its common center of gravity will draw nearer the sun.

Putting

$d =$ difference of gravitation,
$a =$ distance of the center of the comet from the sun,
$R =$ radius of the comet,
$g =$ gravitation in the distance a,

we have,

$$d = \frac{g}{(a - R)^2} - \frac{g}{(a + R)^2} = \frac{g\, \{(a + R)^2 - (a - R)^2\}}{(a + R)^2\, (a - R)^2} = \frac{4\, g\, a\, R}{a^4 - 2\, a^2\, R^2 + R^4}.$$

But in our solar system the diameters of the planets and comets are very small in proportion to their distances from the sun, and those terms multiplied by R^2 and R^4 can be neglected; hence,

$$d = \frac{4\, g\, R}{a^3}.$$

The diameter of Encke's Comet is about $3' = 30{,}000$ miles in round numbers, or $R = 0.0001428 \times$ mean distance of the earth from the sun. In the perihelion there is the gravitation of the comet towards the sun in 1 day $= g = 0.0022510$ times the mean distance of the earth, and therefore $d = 0.000031602$. The perturbation in the radius-vector will be very nearly $= -\frac{d}{2} = -0.000015801 = \delta\, r$ in 1 day. The gravitation for other distances is,

$$g' = \frac{g\, p^2}{r'^2}, \qquad p = \text{perihelion distance},$$

and

$$\delta\, r' = \frac{g'\, p^3}{g\, r'^3} . \delta\, r,$$

or, by substituting the value of g',

$$\delta r' = \frac{p^5}{r'^5} \cdot \delta r,$$

Now there is the following theorem: —

A perturbation in the radius-vector, independent of the time and only a function of the radius-vector, does not change the dimensions of the orbit, because by that, as it were, only the force of the central body is changed, but not the law of its action affected. That theorem therefore rests on the supposition, that the perturbation is in the inverse ratio of the square of the radius-vector. The above-obtained perturbation, however, is in the inverse ratio of a higher power of the radius-vector. In the computation of the following perturbations, from day to day, and starting from the perihelion, the ephemeris for 1838 given in the Berlin *Astronomisches Jahrbuch* for 1840 was used, and the following values thus obtained.

1838.	$\frac{p^5}{r'^5}\cdot\delta r = -0.0000$	1838.	$\frac{p^5}{r'^5}\cdot\delta r = -0.0000$
Dec. 20.5	15262	Nov. 6.5	00076
Perih. Passage, 19.5	15549		70
18.5	15549		65
	15262		60
	14391		55
	13201		51
	11820	Oct. 31.5	48
	10390		44
	8987		41
	7675		39
	6495		36
	5471		33
	4588		32
	3842		30
	3218		28
	2701		26
	2270		25
	1915		23
	1620		22
Dec. 1.5	1378		21
Nov. 30.5	1175		20
	1007		19
	866		18
	748		17
	650		16
	566		15
	494		14
	431		14
	382		13
	338		12
	300		12
	267		11
	239		11
	214		10
	192		10
	173		9
	156	Oct. 1.5	00009
	142		
	129		
	117		
	107		
	98		
	89		
Nov. 7.5	82		

An estimation of the perturbations from this last point back to the aphelion is = 23 units of the last figure.

The sum of the perturbations from the perihelion back to October 1.0, 23 in all, that is in half the period, is = —0.000140816; therefore in the whole period,

$$\int \delta r = -0.000281632 = \delta a;$$ where a = mean distance of the comet.

If U = period of the earth, and u = period of the comet, we have,

$$\delta u = \frac{3}{2}\frac{U^2 a^2}{u} \cdot \delta a$$
$$= -0.230 \text{ days} = -5.52 \text{ hours},$$

which is exactly the result Professor Encke derived from the observations.

Cambridge, Mass., 1852, *January* 6.

OBSERVATIONS OF THE FIRST COMET OF 1850, MADE AT THE OBSERVATORY AT BILK.

1850.	M. T. Bilk.	Apparent α.	Apparent δ.
	h. m. s.	° ′ ″	° ′ ″
May 8	11 40 14.0	☄ — * = —1 4 53.10	☄ — * = + 0 14 3.1
10	10 12 47.9	287 52 57.3	+72 37 49.6
14	11 11 33.1	285 12 2.7	73 13 50.9
16	10 27 4.2	283 35 35.1	73 29 42.1
18	10 38 51.6	281 12 13.1	73 44 13.2
20	10 44 13.4	279 34 55.8	73 56 56.2
29	11 14 0.9	☄ — * = —14 56.85	☄ — * = +11 54.24
30	13 25 58.3	265 4 43.5	74 9 7.8
31	13 25 34.4	263 20 9.9	74 3 39.4
June 1	11 34 59.7	261 41 15.0 : :	73 57 23.4 :
2	11 27 13.4	259 51 54.5	73 48 37.5
4	11 21 44.8	256 7 49.9	73 25 50.9
5	13 44 28.9	254 2 23.5	73 9 52.6
7	13 55 13.2	250 11 19.2	72 33 44.6
8	11 33 30.7	248 27 52.9	72 14 21.5
9	12 6 36.1	246 31 6.5	71 49 51.3
10	11 37 6.9	244 40 30.9	71 23 49 9
20	11 36 39.8	227 51 41.5	64 4 52.0
21	10 58 3.9	226 29 41.4	63 3 35.3
22	11 35 37.9	225 6 2.5	61 53 26.6
24	12 21 43.6	222 30 32.4	59 20 34.1
25	11 23 39.8	221 21 41.8	58 1 27.8
27	12 25 49.1	219 3 31.5	54 57 30.7
30	11 50 2.4	216 3 18.6	49 48 48.9
	12 33 26.2	216 1 38.7	49 45 28.2
July 5	11 43 39.9	211 47 58.0	+39 13 24.4

OBSERVATIONS OF THE SECOND COMET OF 1850.

1850.	M. T. Bilk.	Apparent α.	Apparent δ.
	h. m. s.	° ′ ″	° ′ ″
Sept. 12	12 41 42.9	101 40 51.2	+18 56 57.5
14	14 19 55.3	☄ — * = +6 29.85	☄ — * = +0.40
16	15 22 1.8	115 50 42.3	39 55 4.0
17	15 26 17.8	118 54 20.3	37 19 25.8
18	15 49 43.2	121 50 57.5	+31 36 40.6

F. BRÜNNOW.

SOME IRIS OBSERVATIONS OF THIS YEAR COMPARED WITH THE THEORY.

By E. SCHUBERT.

[Communicated by Lieutenant C. H. Davis, Superintendent of the Nautical Almanac.]

Iris was this year not very far from her perihelion (approaching it), last year, on the contrary, near her aphelion (leaving it); so that, on account of the considerable eccentricity of the orbit, her distance from the earth in the opposition was this year only 0.9, last year 1.9. It was to be expected, therefore, that some slight uncertainties in the elements might be shown by the observations of this year. I was very anxious to know the difference as soon as possible, and am much obliged to Lieutenant Maury, Superintendent of the National Observatory, for his kindness in sending me the first five observations made by Mr. Ferguson, about four weeks before the opposition immediately after they had been reduced. They are corrected for refraction, parallax, and the times of observation, being corrected for aberration, and reduced to the meridian of Berlin, as follows: —

1851.	⑦ α	⑦ δ	Comp.	
August 12.73326	3° 17′ 35″.7	+11° 33′ 30″.2	3	with the same star.
13.71281	3 19 5.7	11 38 38.5	14	
16.72040	3 21 8.4	11 53 11.3	20	with two stars.
27.74998	2 52 58.4	12 28 11.0	9	with the same star.
28.67982	2 48 3.6	+12 29 41.1	8	

For the comparison were obtained the osculating elements, —

1851, August 13.0, M. T. Berlin.

M	324° 7′ 18″.34	
☊	259 43 36.04	Mean Equinox of the Epoch.
π	41 21 57.17	
i	5 28 14.12	
φ	13 26 13.63	
μ	963″.07374	
Log. a	0.3775647	

and the respective differences, —

Calc. — Obs. $\Delta\alpha\cos\delta$	Calc. — Obs. $\Delta\delta$
+1″.1	+4″.8
4.1	5.5
+5.3	+5.5
+10″.1	+5″.1
+10.4	+5.1
Mean, +6.2	+5.2

These differences are very nearly the same as last year, so that there has been no increase; and they would have been considerably magnified this year in consequence of the relatively great proximity to the earth. *Iris* has since my determination of its orbit performed a whole revolution, and the difference between calculation and observation has been during that interval always so small, that it can be accounted for by the uncertainties in the observations and in the positions of the comparison-stars. Therefore, I believe, we are authorized to consider the orbit of *Iris* as definitely ascertained.

Cambridge, Mass., 1851, *October* 1.

FOURTH LIST OF ERRORS IN PUBLISHED CATALOGUES OF STARS, DETECTED BY THE U. S. N. ASTRONOMICAL EXPEDITION TO CHILI.

[Communicated by Professor Coffin.]

British Association Catalogue.

No. 7619. There is no such star.

" 7938. The polar distance of Lacaille is right. It is wrong here.

Lacaille's Catalogue.

No. 349. There is a mistake here, as it does not correspond with Brisbane 173 reduced, and we find no such star.

" 4551. P. D. in error —3′.

" 7356. A nebulous cluster in which there is no star brighter than 10 magnitude.

" 7678. P. D. in error —3′.

" 8042. No star within $2^{m.}$ α and 10′ P. D. as bright as 9 magnitude.

" 8145. P. D. in error +2′.

" 8171. Does not exist here.

No. 8203. P. D. in error —2′.

" 8460. Not found in three searches.

" 8493. Nearest star so bright as 10 magnitude is 7′ north and precedes $30^{s.}$.

" 8510. P. D. in error +2′.

" 8696. Not found in three searches.

" 8703. P. D. in error —3′ 30″; α too great $30^{s.}$.

" 8975. Brisbane right. There is no star in place of Lacaille's.

" 9193. α $5^{s.}$ too little, P. D. +4′.

" 9374. P. D. in error +4′.

" 9390. Brisbane right.

" 9409. α in error $+10^{s.}$.

The errors of right-ascension and P. D. given are only approximate.

J. M. GILLISS.

OBSERVATIONS OF ENCKE'S COMET,

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By Mr. JAMES FERGUSON.

[Communicated by Lieutenant Maury.]

[Corrected for refraction.]

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	☄ − * Δα	☄ − * Δδ	☄'s apparent α	☄'s apparent δ
1852.	h. m. s			m. s.	′ ″	h. m. s.	° ′ ″
Jan. 12	6 47 3.0	4	Weisse XXIII. 48	+1 45.82	−7 5.69	23 5 26.9	+4 4 53.4
		4	" 111	−1 0.29	−6 35.39	23 5 27.3	4 4 52.8
14	6 41 7.9	6	" 111	+1 19.86	+3 24.18	23 7 47.4	+4 14 52.5

The comet resembles a faint white nebula, bearing scarce any illumination. At the last observation it was more distinctly seen than at the first.

Adopted Mean Places, 1850.0, *of Comparison-Stars.*

*	Mag.	α	δ	Authority.
		h. m. s.	° ′ ″	
Weisse XXIII. 48	(7.8)	23 3 36.65	+4 11 26.75	Santini's Catalogue.
" 111	8	23 6 23.12	+4 10 56.01	Weisse's Catalogue.

SUPPOSED NEW PLANET.

Dr. Petersen issued a circular, December 22, announcing that Professor de Gasparis in Naples had discovered close to *Saturn*, December 8, a very faint star, which he considered a new planet, — but had not been able to estimate its magnitude on account of the brightness of the moonlight.

Since Professor Gasparis remarks that he was able to distinguish the satellite *Iapetus*, it appears improbable that the object observed could have been a satellite, and Dr. Petersen has therefore thought it best to communicate the information directly to astronomers.

Comparisons of the Supposed Planet with Saturn.

	M. T. Naples.	α Saturn — Planet.	δ Saturn — Planet.
		s.	′ ″
1851, Dec. 8	7 10 6.4	+31.7	+2 55
9	7 0 40.3	+30.5	+2 59

Dr. Petersen writes, under date of December 23, that cloudy weather had prevented him from finding the object.

G.

Cambridge, 1852, *January* 9.

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New Elements of Egeria, and Ephemeris for 1852, by Professor J. S. Hubbard.
Two New Theorems, and Solution of a Problem, by Rev. Thomas Hill.
On Encke's Comet, by Mr. E. Schubert.
Observations of the First and Second Comets of 1850, made at the Observatory at Bilk, by Dr. Brünnow.
Some Iris Observations of this Year compared with the Theory, by Mr. E. Schubert.
Fourth List of Errors in published Catalogues of Stars, detected by the U. S. N. Astronomical Expedition to Chili.
Observations of Encke's Comet, made with the Filar-Micrometer of the Washington Equatorial, by Mr. James Ferguson.
Supposed New Planet.

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THE

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OBSERVATIONS OF EUNOMIA,

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By Mr. JAMES FERGUSON.

[Communicated by Lieutenant Maury.]

[Corrected for refraction.]

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	⑮ — *		⑮'s apparent		A.
				Δα	Δδ	α	δ	
1851.	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″	
Sept. 1	9 44 18.6	4	B. A. C. 6161	+6 35.05	+ 4 14.61	18 9 14.69	—23 39 12.94	10
	9 51 56.0	9	*A*	+0 41.62	— 1 5.72	9 14.92	39 11.35	10
2	7 39 9.6	9	*A*	+0 58.92	+ 2 20.72	9 32.30	35 45.74	10
4	8 42 51.6	7	*A*	+1 43.22	+10 1.71	10 16.77	28 3.99	10
	8 44 49.2	6	Lalande 33684	—0 36.62	— 5 56.34	10 16.26	23 28 8.53	10
16	8 54 55.5	7	B. A. C. 6222	+3 47.33	+13 32.31	16 50.92	22 45 38.84	9
18	8 34 16.0	10	*a*	—1 16.06	+16 9.97	18 11.33	38 16.02	8
19	7 57 31.1	1	"	—0 31.97	+19 30.06	18 55.30	34 56.95	8
20	8 6 46.1	10	*b*	+1 1.83	+15 5.77	19 41.35	31 24.93	10
21	8 14 3.2	10	*c*	+1 15.05	+ 2 3.14	20 28.00	27 58.13	10
	8 9 32.2	5	Lalande 34222	—3 4.87	— 4 15.29	20 28.19	27 49.77	10
24	8 10 17.1	3	"	—0 31.69	+ 6 1.09	22 58.29	17 33.45	10
		3	Lalande 34229	—0 49.37	— 3 23.80	22 58.33	17 29.27	10
25	8 3 30.0	12	" 34222	+0 17.44	+ 9 26.86	23 50.41	14 7.72	10
		12	" 34229	+0 2.99	+ 0 1.92	23 50.57	14 7.61	10
26	8 2 46.0	7	" 34222	+1 10.94	+12 53.70	24 43.89	10 40.87	10
	8 3 32.1	5	" 34229	+0 56.77	+ 3 27.84	24 44.34	10 37.86	10
	8 35 37.1	10	" 34222	+1 12.23	+12 59.32	24 45.18	10 35.25	10
		10	" 34229	+0 57.73	+ 3 32.89	24 45.30	22 10 32.81	10
Oct. 3	8 35 7.0	6	*d*	+2 59.64	+ 2 41.05	31 35.63	21 46 25.62	10
6	7 54 41.4	5	*e*	+2 57.76	+11 19.71	34 45.62	36 2.91	8
7	7 18 39.2	4	"	+4 2.67	+14 47.19	35 50.51	32 32.45	10
8	7 32 31.4	6	*g*	+0 55.98	+ 1 31.96	36 57.95	28 55.61	9
9	7 30 55.1	6	"	+2 4.24	+ 5 6.33	38 6.21	25 21.27	10
10	7 28 33.7	7	"	+3 13.74	+ 8 43.91	39 15.67	21 43.73	9
13	7 41 22.4	6	B. A. C. 6461; Gr. 12 Y. C. 1661	—6 2.38	+ 7 7.61	42 49.23	10 37.76	9
15	7 13 6.3	5	" "	—3 37.13	+14 34.19	45 14.46	21 3 11.22	10
17	6 42 57.2	20	B. A. C. 6454	—0 46.76	— 4 58.69	47 43.67	20 55 38.22	10
19	6 34 22.4	12	"	+1 47.50	+ 2 47.61	50 17.90	47 52.25	10
20	6 28 31.1	5	"	+3 4.54	+ 6 42.39	51 34.92	43 57.26	10
23	7 18 6.6	8	*k*	+1 44.11	+ 5 15.60	55 37.37	31 44.62	8
24	6 42 27.8	2	"	+3 3.81	+ 9 16.26	18 56 57.08	27 43.99	10
27	7 9 58.1	12	B. A. C. 6550	+0 5.48	—13 6.56	19 1 7.29	20 15 11.48	10
31	7 5 35.9	17	Lalande 36087	+0 8.73	+ 4 42.39	6 49.23	19 57 31.25	9
Nov. 1	7 48 59.2	4	"	+1 38 52	+ 9 23.41	8 19.01	52 50.26	10
6	7 17 10.1	9	B. A. C. 6616	+2 49.41	+ 0 56.26	15 43.51	29 29.31	9
7	7 34 4.5	6	*i*	+0 52.32	— 4 15.60	17 13.07	24 32.86	9
11	6 18 27.2	6	B. A. C. 6707	—4 25.02	+ 5 45.73	23 20.84	19 4 45.48	8
15	6 8 27.6	10	" 6710	+1 13.55	—10 14.12	19 29 38.84	—18 43 30.71	8

Date.	M. T. Washington.	No. of Comp.	Comparison Star.	⑮ — * Δα	⑮ — * Δδ	⑮'s apparent α	⑮'s apparent δ	A.
1851.	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″	
Nov. 17	6 19 15.4	5	B. A. C. 6710	+4 26.52	+ 0 40.68	19 32 51.77	—18 32 35.93	8
26	7 13 27.4	3	*m*	—1 11.83	—10 35.38	47 44.98	17 39 10.07	7
28	7 7 15.1	8	Lalande 38140	—1 57.86	—10 34.95	51 2.74	26 41.54	10
29	6 27 58.8	10	"	—0 15.14	— 4 1.98	52 45.13	20 7.60	9
Dec. 1	5 58 10.2	6	"	+3 7.09	+ 9 0.22	56 7.66	7 6.49	8
	6 35 29.0	10	Madras 1483	—0 43.11	—19 43.01	19 56 10.96	17 7 2.45	8
11	6 33 11.9	14	Lalande 39247	+1 6.92	— 6 3.16	20 18 50.36	15 33 38.39	9
17	6 28 31.2	6	Weisse XX. 664	—2 16.63	—13 20.16	24 10.19	10 4.77	4
18	6 22 12.1	16	"	—0 29.84	— 5 22.41	25 56.85	15 2 6.79	8
19	6 17 33.1	15	"	+1 17.31	+ 2 45.13	27 44.07	14 53 59.25	8
23	6 11 51.2	12	Weisse XX. 860	+1 22.78	+ 4 54.51	34 56.16	14 20 48.42	7
26	6 7 25.9	16	" 1031	+0 0.78	+10 6.79	40 21.68	13 35 2.74	7
1852								
Jan. 1	5 51 18.7	3	Weisse XX. 1394	—2 59.31	+ 0 28.13	20 51 17.84	13 1 5.69	6
7	6 15 47.9	10	Gr. 12 Y. C. 1888	+0 51.86	— 5 32.29	21 2 21.21	12 3 42.88	8
13	6 9 3.3	3	Weisse XXI. 346	—1 41.84	+ 9 15.79	13 27.61	11 3 59.08	6
14	6 4 22.6	5	"	+0 9.03	+19 33.69	21 15 18.38	—10 53 41.00	

These observations to September 21, and the observation of October 27, have been published in the *Astronomical Journal*, No. 33.

Adopted Mean Places, 1850.0, *of Comparison-Stars.*

*	Mag.	α	δ	Authority.	No. of Comp.
		h. m. s.	° ′ ″		
B. A. C. 6161	6	18 2 31.1	—23 43 31.1	British Association Catalogue.	
A	8.9	8 27.73	23 38 10.0	Washington Equatorial, from preceding.	3
Lalande 33684	8.9	10 47.36	23 22 16.87	Lalande's Catalogue.	
B. A. C. 6222	7	12 58.28	22 59 16.00	British Association Catalogue.	
" 6266	7	19 1.19	23 5 18.2	" "	
a	9	19 21.97	22 54 31.64	Washington Equatorial, from 6266.	6
b	9	20 37.83	22 46 36.53	" from *a*.	9
c	9	19 8.70	22 30 6.99	" from *b*.	9
Lalande 34222	9	23 27.79	22 23 40.77	Lalande's Catalogue.	
" 34229	8	23 42.42	22 14 11.99	"	
B. A. C. 6336	6.7	28 55.50	21 31 0.7	British Association Catalogue.	
d	9.10	28 30.99	21 49 13.42	Washington Equatorial, from 6336.	8
e	9	31 42.87	21 47 26.89	" from *d*.	5
g	9	35 57.00	21 30 35.45	" from *e*.	5
B. A. C. 6461	4	48 46.69	21 17 54.69	Greenwich 12 Year Catalogue.	
" 6454	6	48 25.59	20 50 48.9	British Association Catalogue.	
k	9	18 53 48.53	20 37 10.14	Washington Equatorial, from 6454.	4
B. A. C. 6550	7	19 0 57.10	20 2 15.8	British Association Catalogue.	
Lalande 36087	8.9	6 35.84	20 2 25.08	Lalande's Catalogue.	
B. A. C. 6616	7	12 49.50	19 30 37.70	British Association Catalogue.	
i	9	16 18.66	19 20 29.19	Washington Equatorial, from 6616.	7
B. A. C. 6707	7	27 41.31	19 10 44.7	British Association Catalogue.	
" 6710	7	28 20.78	18 33 30.4	" "	
Lalande 38140	8	52 56.15	17 16 22.87	Lalande's Catalogue.	
m	9	48 52.35	17 28 50.81	Washington Equatorial, from 38140.	3
Madras 1483	8	19 56 49.65	16 47 36.13	Madras Catalogue.	
Lalande 39247	8	20 17 39.09	15 27 53.37	Lalande's Catalogue.	
Weisse XX. 664	9	26 22.33	14 57 3.64	Weisse's Catalogue.	
" 860	9	33 29.04	14 26 2.75	"	
" 1031	8.9	40 16.55	14 5 29.91	"	
" 1394	7	20 51 12.84	13 1 55.31	"	
Gr. 12 Y. C. 1888	4.5	21 1 25.11	11 58 32.86	Greenwich 12 Year Catalogue.	
Weisse XXI. 346	8.9	21 15 5.01	—11 13 37.66	Weisse's Catalogue.	

LETTER FROM LIEUTENANT MAURY, SUPERINTENDENT OF THE WASHINGTON OBSERVATORY.

National Observatory, Washington, 1852, *January* 5.

Since my communication of the 3d September, 1851, relative to the missing star of October, 1850, I have had a thorough examination made of the part of the heavens in which it was seen, but without its rediscovery.

The search has been conducted by Mr. Ferguson, with the large Equatorial, upon the supposition that the missing star was not an asteroid, but an exterior planet. The search commenced August 29, and terminated December 11, 1851, extending down to all stars of the 11th magnitude, between 19^{h} 20^{m} and 19^{h} 36^{m} R.A., and —19° to —21° 20′ Decl.

This star was first observed by Mr. Ferguson on the night of October 16, 1850, when he was looking for *Hygea*. It was observed also on the night of the 19th, with two unknown stars, and again on the nights of the 21st and 22d, with the asteroid.

Observations of the Missing Star k, October, 1850.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	$k - *$ $\Delta\alpha$	$k - *$ $\Delta\delta$	A.	Remarks.
1850.	h. m. s.			m. s.	′ ″		
Oct. 16	6 52 36.3	2	Gr. 12 Y. C. 1719	+3 53.70	+10 0.61	6	
19	7 30 28.5	5	*o*	—1 21.80	+ 7 18.56	7	This star observed for *Hygea*.
19	7 27 28.5	1	*p*	—4 57.74	— 9 9.31	7	
21	7 6 39.9	3	*Hygea.*	—3 36.91	+ 4 57.31	7	Doubtful if planet, and very badly seen.
22	6 35 35.1	1	Lalande 36878	—5 33.47	— 2 21.68	8	

From which are deduced the following as the *apparent* places of *k*, corrected for refraction, on the nights of the 16th, 21st, and 22d.

Apparent Places of k.

		α	δ
	h. m. s.	h. m. s.	° ′ ″
Oct. 16	6 52 36.3	19 17 42.81	—20 44 57.096
21	7 6 39.9	19 17 42.19	20 41 55.53
22	6 35 35.1	19 17 43.90	—20 44 54.642

Stars *o* and *p* have not yet been determined with sufficient accuracy to show the place of *k* on the night of the 19th.

M. F. MAURY.

NOTE FROM MR. W. C. BOND, DIRECTOR OF THE CAMBRIDGE OBSERVATORY.

Harvard Observatory, 1852, *January* 20.

The following observations of Encke's Comet were obtained by the micrometer of the great Equatorial: —

1852, January 13, 6^{h} 57^{m} $28^{s}.46$, Cambridge M. S. T.
☄'s R.A. 23^{h} 6^{m} $38^{s}.08$ 17 observations
" δ +4° 9 31″.9 6 "
depend on star *a*, Weisse XXIII., No. 111,
R.A. 23^{h} 6^{m} $29^{s}.23$; δ +4° 11′ 34″.8.

January 17, 7^{h} 2^{m} $16^{s}.07$.
☄'s R.A. 23^{h} 11^{m} $33^{s}.27$ 15 observations
" δ +4° 32′ 29″.4 10 "
depend on star *b*, B. A. C. No. 8127,
R.A. 23^{h} 12^{m} $48^{s}.19$; δ +4° 34′ 26″.5.

January 19, 7^{h} 24^{m} $35^{s}.76$.
☄'s R.A. 23^{h} 14^{m} $10^{s}.06$ 9 observations
" δ +4° 45′ 12″.5 7 "
Comparison-star *c* (determined from B. A. C. No. 8127),
R.A. —23^{h} 14^{m} $31^{s}.28$; δ +4° 41′ 39″.9.

The places are given for the mean equinox January 1st, 1852. The observations agree very closely with the ephemeris of Professor Encke, *Astr. Nachr.*, No. 783.

W. C. BOND.

ON SCHUBERT'S REMARKS UPON ENCKE'S COMET.

By THE EDITOR.

Mr. Schubert's services to astronomy furnished a sufficient reason for inserting, in the last number of this Journal, his article upon Encke's Comet, — the publication of which will not, it is hoped, be censured by astronomers. But having reserved at the time the privilege of criticism in the present number, I wish to state a few of the reasons which prevent me from coinciding with Mr. Schubert's views.

1. The first equation does not appear to be in strict conformity to the law of gravitation, — as, after assuming g to be the force of gravity at the distance a, he uses it as equivalent to the action of the same force at the unit of distance. The difference of gravitation for the two extremities of that diameter of the comet which forms part of the radius-vector, is not $\frac{g}{(a-R)^2} - \frac{g}{(a+R)^2}$, as given by Mr. Schubert; but with his definition of g it is $a^2\left(\frac{g}{(a-R)^2} - \frac{g}{(a+R)^2}\right)$.

2. The disturbing force is that change of the attraction which would arise from the change in the figure of the comet, consequent upon its elongation. It is the difference between the attractive force acting on the comet, and that which would act were the mass of the comet collected at its center, — and may easily be deduced from the formulas in the second volume of the *Mécanique Céleste*, Book III. § 7 (Bowditch's ed. [1428, 1420, 1424]). If, with Mr. Schubert, we take for granted that the form which the comet assumes is that of a spheroid of revolution, — which I may for convenience assume to be elliptical, — the disturbing force will be $= \frac{3}{5}\frac{m\,\theta}{a^4}$, and therefore not inversely proportional to the cube of the distance from the sun, as Mr. Schubert intimates.

3. Mr. Schubert thus makes d in his second equation to be inversely proportionate to the fifth power of the distance from the sun, — not to the cube as it is if it denote the difference of attraction, or to the fourth power as it will be when we consider it as the disturbing force.

4. Mr. Schubert states a theorem which is not correct. The true theorem to which he probably referred is this, — that any perturbation in the direction of the radius-vector, which is only a function of the radius-vector, does not affect the mean time of revolution; i. e. it will not prevent a perfect equality of the intervals of successive return to the perihelion.

5. This theorem does not rest upon the supposition that the perturbation is in the inverse ratio of the square, or of any other power of the radius-vector.

6. Mr. Schubert has computed the perturbations for successive days according to his formula, and added them together, in order to obtain the total variation; but he has in no case taken into account the modification of the motion which would have arisen from the previous perturbations. The unit of time which he has used is one day. The amount of perturbation varies with the square of the time, while Mr. Schubert's calculations are based upon the supposition that it is proportional to the time. Had he taken as unit the gravitation toward the sun in one hour, instead of one day, and computed according to the same method, his result would have been one twenty-fourth part of that which he has obtained. On the other hand, the use of weeks as units would have given him an effect seven times as strong.

7. The result which Professor Encke derived from his observations is an acceleration only half as great as that stated by Mr. Schubert. This is, however, of minor importance, — since the acceleration observed might be deduced from Mr. Schubert's data, by computing the perturbations for half-days according to the same method.

8. No account is taken of the variations observed in the dimensions of the comet; and I have been unsuccessful in endeavors to reproduce the numerical values which Mr. Schubert has given as the basis of his computations, but which exhibit singular discrepancies.

METHOD OF DEDUCING THE VALUE OF A MICROMETER SCREW FROM OBSERVATIONS OF A CIRCUMPOLAR STAR NEAR CULMINATION OR ELONGATION.

By J. E. HILGARD,
ASSISTANT U. S. COAST SURVEY.

[Communicated by Professor A. D. Bache, Superintendent.]

Call T the time of culmination, or elongation, or any convenient time near the star's crossing the middle of the field, t the time of any observation, r the corresponding reading, $T - t = h$; $\Delta =$ north polar distance of star.

Make $$\frac{\sin h \sin \Delta}{\sin 1''} = f.$$

Compute f_1, f_2, f_3, &c., for each observation. Let R be the unknown micrometer reading corresponding *exactly* to the time

T. Find R, the same quantity approximately, and make $\mathfrak{R} = R + \varrho$, when ϱ is the unknown correction.

Further, let V be the unknown value of one micrometer division, v the assumed value, and ω the correction required, so that $V = v + \omega$.

Now compute for each observation $v\,(R - r)$ and we have

$$f_1 - v\,(R - r_1) = d_1 = v\,\varrho + \omega\,(R - r_1)$$
$$f_2 - v\,(R - r_2) = d_2 = v\,\varrho + \omega\,(R - r_2)$$
$$f_3 - v\,(R - r_3) = d_3 = v\,\varrho + \omega\,(R - r_3)$$
$$\&c. \qquad\qquad \&c.$$

And finally,

$$\Sigma v^2 \varrho + \Sigma v\,(R - r)\,\omega = \Sigma v\,d$$
$$\Sigma v\,(R - r)\,\varrho + \Sigma (R - r)^2\,\omega = \Sigma (R - r)\,d$$

whence ω and ϱ are obtained.

The formation of the $v\,(R - r)$ and the $(R - r)^2$ are the only parts of this process that require more time than the approximate method generally used. The advantage of having a result independent of any arbitrary combination must fully counterbalance the increased labor.

The approximate reading R can easily be found by interpolation. As it is immaterial, within certain limits, which absolute moment of time is chosen for T, it is in practice convenient to take an even 10 division of micrometer for R, and to find by interpolation the nearest second of time corresponding to it, and use that as T, to count the hour angles from. An example is annexed to show the form of computation.

For value of micrometer screw of zenith-telescope, No. 3.
Cape Disappointment, Oregon.
Upper culmination of λ *Ursæ Minoris.*

September 17, 1851, ✱'s R.A. · $20^{\mathrm{h.}}\ 12^{\mathrm{m.}}\ 32^{\mathrm{s.}}.62$
Chronometer slow, · · · · · · · 5 5 31.65

Upper culmination by chronometer, 15 7 0.97
Assume $R = 1150$, $v = 0''.466$

$\Delta = 1^{\circ}\ 7'\ 49''.2$ log. sin 8.29506
log. sin $1''$.4.68557
3.60949

$T = 15^{\mathrm{h.}}\ 7^{\mathrm{m.}}\ 1^{\mathrm{s.}}$.

No.	Micrometer Reading.	h	Log. sin h Log. f	$R - r$	$v\,(R - r)$	f	d	$d\,(R - r)$	$(R - r)^2$
		m. s.							
1	25	29 32.3	9.10900 2.71849	+1125	+524.2	+523.0	—1.2	—1350.0	1265625
2	50	28 56.1	9.10008 2.70957	1100	512.6	512.4	—0.2	— 220.0	1210000
3	75	28 17.0	9.09024 2.69973	1075	501.0	500.9	—0.1	— 107.5	1155625
4	100	27 36.3	9.07975 2.68924	1050	489.3	488.9	—0.4	— 420.0	1102500
5	125	26 57.9	9.06961 2.67910	1025	477.6	477.6	0.0	0.0	1050625
6	150	26 18.7	9.05901 2.66850	1000	466.0	466.1	+0.1	+ 100.0	1000000
7	175	25 40.4	9.04840 2.65789	+975	+454.4	+454.9	+0.5	+ 487.5	950625

In this set 65 observations were used.

$$\Sigma v^2 = 14.115,\ \Sigma v\,(R - r) = +3704.7,\ \Sigma v\,d = +28.565,\ \Sigma (R - r)^2 = 17460000,\ \Sigma d\,(R - r) = +8547.5$$

Hence the equations,

$$14.115\,\varrho + 3704.7\,\omega = 28.565$$
$$3704.7\,\varrho + 17460000\,\omega = 8547.5$$

from which $\omega = +0.000064$ and $\varrho = +2.007$.

Hence, $V = 0''.466064$.

RESULTS OF OBSERVATIONS FOR DETERMINING THE RELATIVE BRIGHTNESS OF THE ASTEROIDS,

MADE WITH THE WASHINGTON EQUATORIAL, IN 1849, 1850, 1851, AND 1852.

By MR. JAMES FERGUSON.

THESE observations have been made, for the most part, at the times when the asteroids were observed for position, and also whenever the condition of the atmosphere and the position of the asteroids were favorable for the purpose. The method used has already been briefly explained in a note accompanying the observations of *Metis*, published in the *Astronomische Nachrichten*, No. 779, and in the *Astronomical Journal*, No. 30. The comparisons of 1849, and great part of 1850, were made principally with stars of the Weisse Catalogue, or of Bessel's Zones, but subsequently, and with the view of obtaining greater accuracy, they have been made with double stars of the Mensuræ Micrometricæ, and when practicable with the Pleiades. The results of these comparisons are less certain and satisfactory than was anticipated by the observer until after the observations had been discussed. Their imperfection arises from the two following causes, which may in a great degree be obviated by proper attention. In the first place, the stars set down in the catalogue as of the same magnitude do not always agree when compared directly with each other, which may be owing to the variability of the star, or to differences of atmosphere at the time of observation. In the next place, comparisons made with stars of different magnitudes cannot be used until we have first determined what changes of distance are necessary to make the asteroid pass from one magnitude to the other. To avoid this difficulty hereafter, it is intended to compare all the asteroids with the 9th magnitude only, a value which is more common to the smaller asteroids than any other, and to which the larger ones sometimes approach. In doing this, the results already obtained will be of use as indicating nearly the respective distances at which each asteroid is found near this magnitude.

The following table exhibits the number of comparisons, and the manner in which the results have been derived from them. The quantity C is equal to $\frac{1}{r^2 \Delta^2}$, to which the brilliancy of each asteroid is assumed to be directly proportional. The results derived from comparisons made in the 9th magnitude and marked with an asterisk, are accounted of greater weight for the reasons given above. *Ceres*, *Pallas*, and *Juno* have not yet been compared. *Clio* and *Astræa* are the only asteroids which have given unquestionable evidence of variable light. The observations which have been rejected have been mostly comparisons with the lower magnitudes, — where the C is small. The results of these comparisons in the lesser magnitude are always discrepant and unreliable.

Asteroids.	No. of Comparisons		Values of C at the observed Magnitudes following												Deduced values of C at the Magnitudes				Relative Brilliancy.	Diameters.
	Made	Used	Mag 7	C	Mag. 8	C	Mag. 9	C	Mag. 10	C	Mag. 11	C	Mag 12	C	7.33	8.25	9.00	10.00		
Vesta,	4	4	7.33	0.128											0.128				1.000	1.000
Hygea,	33	7					9.4	0.0148									0.0172		0.739	0.859*
		4							10.3	0.0097										
Flora,	8	4			8.25	0.242										0.242			0.434	0.659
Iris,	32	7					9.0	0.0325									0.0325		0.391	0.625*
		5									11.0	0.016								
		8	7.60	0.305											0.327					
		3			8.40	0.241										0.269				
Hebe,	27	11					9.50	0.030									0.031		0.374	0.611*
		1									11.0	0.019								
Eunomia,	6	6							10.2	0.019								0.021	0.363	0.602
Clio,	21	3							10.0	0.030								0.030	0.254	0.508
		16											12	0.021						
Egeria,	24	2							10.6	0.031								0.036	0.212	0.460
		22									11.47	0.021								
Irene,	21	9					9.6	0.052									0.066		0.193	0.438*
		1									11.5	0.020								
Astræa,	12	7			8.90	0.079														
							9.5	0.068									0.075		0.169	0.411*
											11.0	0.043								
Metis,	39	4					9.0	0.087									0.087		0.146	0.382*
		10					9.53	0.019												
		5									11.0	0.032								
Parthenope,	26	6					9.05	0.088									0.090		0.141	0.375*
		5							10.0	0.051								0.054		
		8									11.0	0.032								

SUPPOSED NEW PLANET OF GASPARIS.

M. **Rümker** of Hamburg observed this object on the 24th December, as follows:—

	Hamburg M. T.	α	δ
	h. m. s.	h. m. s.	° ′ ″
1851, Dec. 24	7 8 4	1 45 32.37	+8 10 22.5

Professor **Challis**, in a communication to the Royal Astronomical Society of London, has announced, that, after considerable pains to arrive at the truth regarding the supposed new planet, he had finally succeeded.

"The object observed by Dr. **de Gasparis**, December 8 and 9, must have been *Iapetus*. By a rough calculation I find that the place of the satellite at that time and its change of position relative to *Saturn* sufficiently accord with the observations. This is the only satellite whose right ascension could differ as much as 30ˢ from that of *Saturn*. Although Dr. **de Gasparis** states that he took account of *Iapetus*, I conceive that he must have mistaken *Titan* for *Iapetus*, or perhaps some other object was supposed to be *Iapetus*. M. **Rümker**'s place is, I conceive, an observation of *Titan*. I ascertained this last night, having found *Titan* in the same position relative to *Saturn* which the object observed by M. **Rümker** had on December 24; and the interval between January 9 and December 24 (sixteen days) is very nearly *Titan's* periodic time. I have seldom, perhaps never, seen the satellites of *Saturn* so bright as they now appear; and I am not surprised that *Titan* should be mistaken for one of the asteroids. It is a good 9th magnitude, and was visible, notwithstanding its proximity to *Saturn*, in the finder of our telescope."

ON THE ORIGIN OF THE FORMS AND THE PRESENT CONDITION OF SOME OF THE CLUSTERS OF STARS, AND SEVERAL OF THE NEBULÆ.

By STEPHEN ALEXANDER,

PROFESSOR OF MATHEMATICS AND ASTRONOMY IN THE COLLEGE OF NEW JERSEY.

The design of this communication is sufficiently evident from its title; but before entering upon the exposition of any hypothesis having reference to its subject-matter, it may be well enough to indicate what may and what may not be hoped for, in such a case, in the present state of our knowledge. This has, in part, been so clearly stated by **Lord Rosse**, in his account of some of his recent discoveries, that we need make no apology for quoting his remarks entire.

"Much, however, as the discovery of these strange forms may be calculated to excite our curiosity, and awaken an intense desire to learn something of the laws of these wonderful systems, as yet, I think, we have no fair ground even for plausible conjecture; and as observations have accumulated, the subject has become, to my mind at least, more mysterious and more inapproachable. There has therefore been little temptation to indulge in speculation, and consequently there can have been but little danger of bias in seeking for the facts. When certain phenomena can only be seen with great difficulty, the eye may imperceptibly be in some degree influenced by the mind; therefore a preconceived theory may mislead, and speculations are not without danger. On the other hand, speculations may render important service by directing attention to phenomena which otherwise would escape observation, just as we are sometimes enabled to recognize a faint object with a small instrument, having had our attention previously directed to it by an instrument of greater power. The conjectures, therefore, of men of science are always to be invited as aids during the active prosecution of research." *

In addition to these conclusions, as just as they are well expressed, it should moreover be borne in mind as a well-recognized principle, that every explanation of a physical phenomenon, or of a combination of such phenomena, should be adequate in two respects, in *mode* and in *measure*; i. e. the explanation should account for the effects in question, as happening in the very way in which they are really found to occur, and the cause or causes assigned should be fully adequate to the production of those effects.†

Now it is quite supposable that an explanation may be altogether adequate in *mode*, while such may be the state of our knowledge, or (as in the case now to be considered) such may be the very greatness of the quantities concerned, or both, that it may as yet be impracticable to show distinctly how far any given explanation of the phenomena may be adequate in *meas-*

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* *Philosophical Transactions for the Year* 1850, pp. 503, 504.

† This, as is here intimated, is not a new principle; and the phraseology of the more important terms employed is not very different from that of **Sir John Herschel**, when, speaking of the suggestion of any new cause for a "residual" phenomenon, he says, "Our first object must of course be to decide whether such a cause would produce *such* a result in *kind*: the next, to assign to it such an intensity as shall account for the greatest possible amount of the residual matter in hand."—*Outlines of Astronomy*, (856).

ure; though we may arrive at a reasonable probability that such is the fact.

The difficulty with reference to "the laws which regulate these wonderful systems," which is alluded to in the passage already quoted, would seem to be wellnigh insurmountable, if by laws we intend to designate such as would prove to be *conservative* in their character, — conservative at least in so far as a certain normal state of the system is concerned; such as, for example, actually prevail in the solar system, and in those of the binary stars.

This in one instance (i. e. of "a *uniform* distribution of stars" in a globular cluster) has been shown to be mechanically supposable, at least in so far as all but the surface stars are concerned;* but the conditions of a *dynamical* equilibrium seem to be inadmissible in the vast multitude of other cases, without the introduction also of other and extraneous considerations, which, however ingeniously and ably presented, and in themselves, it may be, supposable, are yet not such as the phenomena *unequivocally require.*

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* See Sir John Herschel's *Outlines of Astronomy* (866), and his *Results of Astronomical Observations made at the Cape of Good Hope*, p. 139, from which I have also borrowed the happy phrase "a *dynamical* equilibrium."

(*To be continued on next page.*)

CORRIGENDA.

Page 76, June 9,	column of	δ,	for 49″.48,	read 41″.48
" Aug. 12,	"	Δδ,	" 26″.64,	" 27″.64.
" Aug. 14,	"	No. of Comp.	" 11,	" 14.
Page 77, Sept. 20,	"	Δα,	" $13^{s}.84$,	" $14^{s}.14$.
" Oct. 3,	"	Comparison-Star,	" *i*,	" B. A. C. 5730.
" Oct. 6,	"	"	" *i*,	" "
	"	"	" B. A. C. 5752,	" B. A. C. 5742.
" Oct. 7,	"	M. T. Washington,	" $55^{s}.7$,	" $58^{s}.7$.
" Weisse XV. 792,	"	α,	" $23^{s}.81$,	" $22^{s}.81$.
Page 78, Gr. 12 Y. C. 1315,	"	α,	" $44^{m}\ 24^{s}.55$,	" $54^{m}\ 24^{s}.55$.
" 82, April 28,	"	⑬ δ,	" 51′ 66″,	" 51′ 46″.

NOTICE.

As there have already been many cases in which the difficulty of transmitting subscriptions to the *Astronomische Nachrichten* has deterred astronomers from subscribing, the Editor of the *Astronomical Journal* takes this opportunity to say, that it will afford him great pleasure to be of service to any who may desire to subscribe. He will be happy either to transmit subscriptions to his friend Dr. Petersen, — or to aid if possible in making the postal arrangements for the transmission of the *Nachrichten*, — arrangements which have become somewhat more simple since the late reorganization of the German mail system. — A few copies of the *Ergänzungs-heft* still remain in Cambridge.

G.

Cambridge, 1852, *January* 19.

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THE

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ON THE ORIGIN OF THE FORMS AND THE PRESENT CONDITION OF SOME OF THE CLUSTERS OF STARS AND SEVERAL OF THE NEBULÆ.

BY STEPHEN ALEXANDER,

PROFESSOR OF MATHEMATICS AND ASTRONOMY IN THE COLLEGE OF NEW JERSEY.

(*Continued from page* 96.)

THE "*clustering power*" of SIR WILLIAM HERSCHEL was the result of an extensive induction, in the completion of which he displayed his characteristic skill, care, and industry. Its ultimate effects, as contemplated by him, were not, however, wholly conservative; but such as must tend to the breaking up of the Milky Way, and to a species of catastrophe; clusters becoming highly condensed and totally insulated, or even united in distinct single masses, and "nebulous matter" arriving at its highest state of condensation in a stellar nebula, and being ultimately changed into a star.[*]

The remarkable spirals, unknown in SIR WILLIAM HERSCHEL's day, but recently discovered, in the use of an increased optical power, by LORD ROSSE, evidently require something other than the mere *clustering power* for their explanation.

The *nebular hypothesis* of LAPLACE is specific in its application to the solar system, and its applicability to that case may be judged of, without special reference to those appearances among the clusters and nebulæ which may originally have been suggestive of it.

It has long been conceded that the nebular hypothesis when applied to the case of the solar system is adequate in *mode*, and the application of Professor KIRKWOOD's beautiful analogy has enabled Mr. WALKER to show, with some reasonable probability, that this same hypothesis is also adequate in *measure*.[†]

In accounting for the present state of the solar system, as well as for the changes through which it has passed, the hypothesis assumes that the same laws of heat, gravitation, and inertia which are now recognized were also prevalent when the material of the system was very widely diffused.

The consideration of what would be the effects of these or analogous forces excessively accumulated, may enable us to recognize in many of the clusters and nebulæ *the partially scattered fragments of enormous masses, once rotating in a state of dynamical equilibrium; and that the separation of these fragments may still be in progress.*

Now a homogeneous fluid mass, in a state of equilibrium and endowed with a rotatory motion, cannot preserve a spheroidal form if its time of rotation be less than $0^{\mathrm{day}}.10090 \times$ *the square root of the ratio of the mean density of the earth to that of the fluid mass*; and in the case in which this maximum velocity of rotation occurs, the ratio of the equatorial to the polar axis will $= 2.7197$.[*]

In the case in question, the mass must be presumed to have been largely extended and very highly heated, and its mean density, therefore, most probably, was excessively small. If we should suppose the mean density to have been even $\frac{1}{1,000,000,000,000}$th of the present mean density of the earth, it would even then be more than 8,000,000 times as great as SIR WILLIAM HERSCHEL regarded as supposable, in the case of some of the planetary nebulæ in their original state.[†] The planetary nebulæ have indeed been partially resolved, since SIR WILLIAM made his estimate; but, adhering to the estimate here made, and supposing the mass to be homogeneous, we shall have, for the shortest possible time of rotation of a homogeneous spheroid, a period of something more than 276 years; the spheroid being that, as before stated, in which the ratio of the equatorial to the polar axis $= 2.7197$.

With a slower rotation than that which would yield this form, two figures are in general supposable, the one less and the other more oblate than the spheroid of swiftest rotation.[‡] In the case of the earth, the two spheroids would be, the one with the axes in the ratio of 231.7 to 230.7, and the other that in which the ratio would be that of 680.49 to 1.[*] When the rotation is excessively slow, the one of the two spheroids will, in any case, differ but little from a sphere, and the other be very oblate.[*]

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[*] See especially *Philosophical Transactions*, 1785, pp. 255, 265, 266; 1814, pp 282 - 284; and 1811, pp. 330 - 332.

[†] See *Proceedings of the American Association for the Advancement of Science, at its Second Meeting*, pp. 218, 219; also DR. GOULD's remarks, p. 364.

[*] See *Mécanique Céleste*, III. iii. § 20, [1605′] of DR. BOWDITCH's Translation.

[†] See *Phil. Trans.*, 1811, note to p. 319.

[‡] *Méc. Cél.*, III. iii. § 20, [1603″], [1592″], and note (1116).

Either of these two forms is then supposable, in the case of an enormous, highly heated, largely expanded, and (if admissible) also homogeneous mass, when the rotation about its axis is moreover supposed to be very slow.

We are scarcely at liberty, however, to regard the enormous spheroid as having been homogeneous, even upon the first assumption of its form. It would seem to be more probable, that some portion of the material, in consequence of unequal cooling or otherwise, had acquired a somewhat greater density than other surrounding portions; and then, with Sir William Herschel, that the inward tendency of unequally dispersed matter (attracted by the more condensed portion) may itself have originated a rotation of the mass;[†] and then, again, that the *angular* velocity of rotation of the whole at length became the same, by a mutual friction and adjustment of the different portions, very much such as Laplace supposes to have occurred in the case of the equatorial rings, which, according to his hypothesis, were abandoned by the sun.[‡]

All this, however, might not be unattended with essential difficulties; and yet, apart from many of these considerations, a somewhat greater density of the central portion of a rotating spheroid would seem to be the result, if the state of the material of which it was composed were such, that pressure could be propagated from any one portion to another; resisted though that pressure would be by the powerfully repulsive force due to an excessively high temperature, and relieved as the same must also be, to some extent, by the centrifugal force due to the rotation itself.

The present condition, moreover, of very many of the clusters and nebulæ (though now widely different from that here supposed) itself rather seems to indicate that some condensation of the central portions did exist, in their primary state; and even masses of so low a density as many or most of the comets, exhibit more or less of central condensation.

But although all this must be conceded, yet, in view of the opposing causes already specified, we may reasonably infer that the condensation must have been comparatively inconsiderable at the outset. Moreover, one of the forms consistent with a very slow rotation would exhibit a very great deviation from a sphere, even if the uniform density of the whole were quite considerable, as certainly would also largely be the case if the density, also uniform, were very small. Hence (even in the absence of any more special analysis) we may very safely conclude, that the form of the *heterogeneous* mass of slow rotation now in question would, as a whole, be one of *great oblateness;* while it might also be the case, that the more stringent conditions imposed upon the central and more condensed portions would not permit of so great a deviation in the same respect *there*.

In the instance of the other spheroid of slow rotation, viz. that approximating to a sphere, a diminution of the uniform density will require a greater ellipticity, when the time is given; since the ellipticities of two of these homogeneous spheroids will be "*inversely as their densities* × *the square of the times of revolution*."[*] Or, when the times are the same, the ellipticities will be inversely as the densities: a still longer time of rotation, however, indicating a still closer approximation to a sphere in either case.

In a heterogeneous spheroid, increasing like the earth in density toward the center, the more intense action of similar causes may have been attended with a similar result; viz. an ellipticity *less* than that which would have existed had the mass been homogeneous.

From the whole it appears, that, whether we attempt to account for the rotation, or regard it as an ultimate fact, either of the two forms of equilibrium which have been specified is *mechanically supposable*, in the case of an enormous, highly heated, and slowly rotating mass; especially in the case in which the mean density is small, even though the central portions should be the more condensed.

Whether any other forms of (temporary) equilibrium may not also have existed, will be considered, when the two specific forms already in question shall have in some measure been disposed of.

In the discussion of the effects which must probably have ensued from the continued rotation of the spheroids in question, the case of the decidedly oblate spheroid will be first considered; and instances presented of clusters and nebulæ of comparatively simple forms, which seem to be the partially scattered fragments of such a mass; or such as may all be included in

Class I.

(Primitive Form, a highly oblate Spheroid.)

Included in this class, we have,

Order 1st. Spirals.

To show how these would result, the following considerations may suffice.

The surface of a highly oblate spheroid being much greater than that of a sphere of the same capacity, the cooling effect of radiation would be much more rapid than in the case of such a sphere with the same temperature at its surface; especially would this be true, near to what may be termed the equatorial edge of the spheroid. The following effects, therefore, would probably ensue:—

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[*] *Méc. Cél.*, III. iii. § 20, [1603″], [1592″], and note (1116).

[†] *Phil. Trans. for the Year* 1811, p. 312.

[‡] *Exposition du Système du Monde*, 5^{e} édition, p. 436.

[*] Airy's *Mathematical Tracts*, 3d edition, p. 145.

1st. A contraction from the loss of heat.

2d. An increase of the angular velocity of rotation, the *momentum* remaining unchanged.

3d. An increase of centrifugal force.

4th. Some increase of the attractive force of the mass within, due to a decrease of distance.

5th. In consequence of all this, an approximation in the arrangement of the equatorial molecules to that state in which the centrifugal force of rotation would be equal to the attractive force of the mass.

These effects would be analogous to those supposed by the *nebular hypothesis* of LAPLACE to have occurred in the primitive state of the sun; and for similar reasons to those alleged by that eminent astronomer.*

But since the cooling would be more rapid near the thin equatorial edge, and also because of the vast size and the slow motion, we should have, in addition to these effects, —

6th. A sensible increase of density in the equatorial region; and thus an *equatorial ring* of more dense material be constituted; the ring yet adhering to the spheroid.

7th. With the increase of density in the region of the ring or elsewhere, an increase of cohesive force.

8th. An attractive force in the condensed ring which would operate as a *divellent force*, and, as such, be very *efficient* in its action upon those superficial portions of the spheroid immediately adjacent to the ring; because, —

(*a.*) The action of the ring upon these portions would be very direct.

(*b.*) Some of the portions thus acted upon would be immediately adjacent to the ring, and therefore the action be vastly more energetic.

(*c.*) The *difference* between the attractive force exerted by the mass of the spheroid upon the molecules of these portions, and that exerted upon the molecules of the ring, would be relatively small, and with respect to those portions of the surface somewhat more remote, the attractive force of the mass upon them would be comparatively feeble; since in a homogeneous spheroid this force at any point may be represented by the normal,† and its value would be nearly the same in the case here supposed. Now the normal, even near to the equator, would itself be short, and in its position approaching to a *perpendicular* to the direction of the *divellent action.*

For like reasons to some or all of these, this same divellent force of the ring would also be efficient in its action upon other portions *immediately* adjacent and *within* the spheroid.

9th. The transfer of material to the equatorial ring would to some extent tend to the restoration of equilibrium; for this, being in part from within outward, would somewhat diminish the *angular* velocity of rotation. But the effect of this upon the rotation of the *whole mass* must be small, while yet the mass cohered, and this effect must be more than counterbalanced by the contraction of all the outer portions. Meanwhile, — (*a.*) This continued contraction arising from the more rapid loss of heat for some time *there* than in the other portions of the spheroid, and with it the continued accumulation of material throughout *all the wide circuit* of the equatorial ring, must altogether produce an accumulation of centrifugal force there. (*b.*) This, with the repulsive force of heat, must after a time more than counterbalance the united forces of gravitation and cohesion;* not only because of the first five effects which are found here as well as in the instance of "*the nebular hypothesis*," but also because of the destructive tendencies which, *in so huge a mass*, would be accumulated in the ring *condensed* by the *rapid* radiation of a vast surface, at an *enormous* distance from the center. (*c.*) And all this, while the somewhat condensed central portions had as yet been but slightly affected in any way, and the ratio of the increased force of attraction of those portions, though approximating to the inverse ratio of the square of the distance, would exhibit but a *feeble result*. For, (*d.*) The force of the central portions was itself originally feeble, because of their very great distance from the equator: and the attractive force of the portions nearer to the ring had meanwhile been weakened by the loss of material abstracted by the action of the divellent force of the ring itself.

The destructive powers thus accumulated would be for some time resisted by the increased cohesion both of the ring and of the surface of the other portions of the spheroid everywhere cooled; unless, indeed, the transfer of internal heat by conduction, or displacement of material, or both, were more rapid than the loss of heat by radiation: which seems to be scarcely supposable. That the resistance of such a condensed surface portion would be by no means small, the results of capillary action may teach us. As it must soon, however, prove insufficient, the destructive forces must, it would seem, prevail, and the spheroid be *rent* in the region of the equatorial ring.

The result thus arrived at would now seem to be sufficiently obvious, yet it seems not out of place to inquire whether other causes than those already assigned might not combine with them, and thus accelerate the catastrophe?

The cohesive force preserving for some time the spheroidal form, the rapidly cooled surface, and especially the equatorial region, the most cooled of all, might approach to the liquid state, if not become actually *liquid;* or (if that be not accurately descriptive of what would occur) at least undergo what in the *chemical* sense of the term would imply a change of *state*, such as an adequate *loss* of heat would produce. A sudden development of repellent force might be consequent upon this, or as sudden a condensation might speedily augment the effects already specified.[*]

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* *Exp du Syst. du Monde*, 5^e édition, pp. 435, 436.

† AIRY's *Mathematical Tracts*, 3d edition, p. 139.

* The centrifugal force F must vary conjointly as the mass M and the second power of the actual velocity v, and also inversely as the radius r; or $F \alpha \frac{M v^2}{r}$. But if the angular velocity be given, v will itself vary as r, and $F \alpha \frac{M r^2}{r}$; i. e. $F \alpha M r$. The centrifugal force may then be very considerable, when the accumulation of matter is much increased, and the radius very large; even if the *angular* velocity should be quite slow.

However this may be, it would appear to be quite as safe to learn what may happen in a material of small density from that which has occurred in the case of bodies acknowledged to be thus constituted, and whose changes we can observe. Such is the course of reasoning pursued by M. Arago, in commenting upon the condensations described by Sir W. Herschel. M. Arago's remarks are as follows: —

"En attendant, tout nous autorise à supposer que les molécules laiteuses sont soumises dans les vastes régions de l'espace à des forces dont nous n'avons aucune idée. Les observateurs qui ont suivi les changements prodigieux, et souvent presques instantanés de la comète de Halley dans sa dernière apparition, ne me démentiront pas," &c.[†]

Admitting, then, that sufficient causes have been assigned for the destruction of the spheroidal form, the immediate and subsequent effects are next to be considered; which would most probably be such as are in part represented in *Figures* 2, 3, and 4; *Fig.* 1 being a representation of the spheroid itself, viewed in the direction of its axis.

As the cooling and contraction of the equatorial ring could scarcely have been uniform throughout its whole circumference, the destruction of equilibrium would most probably at first be local; the spheroid being broken, as represented in *Fig.* 2.

The cohesion of the cooled and still cooling portion of the part thus projected, being, as before stated, not inconsiderable, and its actual *momentum of rotation* remaining unchanged, its *angular* velocity would forthwith be diminished, and, with that, the angular velocity of that portion of the spheroid immediately attached to it would also be somewhat affected. The stream of ejected material, being thus *relatively* left behind, would assume the form given to it in *Fig.* 3; and be successively broken, first into elongated fragments, and then into what may in comparison be styled *drops*.

This curved portion, by restraining the *angular* velocity of that part of the spheroid to which it was more immediately attached, would moreover tend to *rend* the spheroid, and the more so because the dense outer portion had already been broken, the rent extending in the direction of least resistance; i. e. very possibly, though not of course, toward the center.

The tendency to a rent would be all the greater because of the *enormous size* of the rotating mass, which would prevent any *speedy* communication of a local perturbation; insomuch that a large portion of the whole might for a long time move on with unabated velocity; i. e. for a long time in comparison with our ordinary standards, although but a small fraction of one rotation.

The abstraction of material, the progress of the rent, the tendency toward a new axis of rotation, and the continued action of the same repellent forces, would altogether tend to weaken the part of the mass nearly opposite to that at first broken, and a second stream be ejected at a new fracture, to assume in its progress a very similar form to that of the first, as shown in *Fig.* 4. If the *angular* velocity of the whole mass had, in the mean time, sensibly diminished, the second stream might be somewhat less curved in its appearance than the first.

The spheroid being then again rent, the effect of that — with also the effort at new axes of rotation — and the primary repellent causes might together rend both the elongated remnants, each nearly in the direction of its shortest dimension, and thus four streams, somewhat different in their curvature, be the result; all together presenting the appearance *realized* in the highly beautiful development exhibited in *Fig.* 5, which is a copy of the figure given by Lord Rosse (*Phil. Trans. for* 1850, Plate XXXV. Fig. 2); and represents the nebula M. 99, H. 1173,[*] in the northern wing of *Virgo*.

The primitive spheroid would seem to have been somewhat unequally divided, and the streams on the left and right to have been ejected *first;* as they appear upon the whole more curved in their departure from the central portion; i. e. if the forms are not much distorted by obliquity of view. The left-hand stream was, perhaps, the first of all. The subsequent streams would moreover most probably be larger; and such would seem to have been the fact here, if the upper and lower branches be of later origin.

The rupture of the whole exterior portion of the spheroid must have followed this breaking up; the causes being still in action, and one portion dragging with it another. Then the central and highly heated portions, relieved from the pressure of the vast amount of material between them and the equatorial ring, might undergo a wellnigh simultaneous catastrophe, or be subject to changes such as have been described, though on a smaller scale; if not other changes to be described hereafter, — unless they possessed cohesion enough to have involved them in the rupture of the other portions: which the phenomena do not indicate. Could we be certain that but one rotation had taken place since the ejection of one of these streams, or how far the rotation had advanced at all, some conjecture might be formed as to the ratio of the repellent forces to that of rotation; but of such data we are ignorant.

Fig. 6 represents another instance of a spiral arrangement. The figure is copied from Lord Rosse's (*Phil. Trans. for*

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[*] Sir William Herschel makes some allusion to chemical properties in his account of *Astronomical Observations relating to the Construction of the Heavens.* See especially the reference in his *Synopsis*, in the *Philosophical Transactions for* 1811, p. 333, and the *Concluding Remarks* of that paper; Professor Peirce (*Astronomical Journal*, No. 27) suggests, that, under the modification which a chemical action would suppose, "the nebular hypothesis may possibly be free from some of the objections with which it has been justly assailed"; and Professor Arnold Guyot, in his public lectures in this country, is disposed to insist upon the important part due to chemical action in the early changes contemplated by that hypothesis.

[†] *Annuaire pour l'An* 1842, &c., p. 442. Sir William Herschel intimates that other central powers than attraction may have influence in clusters. *Philosophical Transactions*, Vol. LXXIX. p. 220.

[*] The references here are to be understood as usual: M., the *Catalogue* of Messier; H., that of Sir J. Herschel.

1850, Plate XXXV. Fig. 1), and represents the nebula M. 51, H. 1622, which is situated a short distance below η *Ursæ Majoris.* The figure is much more convoluted than the other, and we may hence conjecture that the catastrophe in this case is of a more ancient date, as *many* rotations seem to have occurred since the spheroid was broken; the density of the equatorial ring appears, moreover, to have been quite considerable, and the oblateness of the spheroid, it may be, was less than that of the other. If, in one instance, the ejection of material was very great, the parts of the large portion thus thrown out at once may have all preserved nearly the same angular velocity, and thus, although it broke into fragments, these remained in the neighborhood of one another. A partial collapse might then be supposable; but whether this occurred or no, the mass might before its rupture have acquired a new rotation, and thus showed us the arrangement at the extremity of a stream, to the right.

It is, however, also supposable that this same nucleus and its proper branch may be the fragments of a second spheroid, which had a rotation in an opposite direction: but this is rendered improbable by the fact that H. 604 (which is represented in Lord Rosse's figures by Fig. 3 of Plate XXXVI. of the same volume), and which, very plainly, is also a spiral, has likewise, unequivocally, a similar appendage; and its dependence is even more evident.

The center of the spiral represented in the figure before us, according to Lord Rosse, was "clearly *resolved*" in the three-foot reflector, and the different convolutions, as viewed in his large telescope, "on the finest nights" were seen "breaking up into stars."[*]

Figs. 7 and 13 are copied from Sir John Herschel's *Results of Observations made at the Cape of Good Hope* (Plate IV. Figs. 6 and 3), and represent, the one H. 2370, and the other H. 3239. Lord Rosse regards these as being "very probably objects of a similar character."[†]

Fig. 11 is from Sir John Herschel's representation in the *Philosophical Transactions for* 1833 (Plate X. Fig. 27), and seems to show a spiral arrangement in the middle. It represents M. 64, H. 1486.

All that has been already stated with regard to these several spirals is confirmed by the *mottled* and very scattered appearance of many parts of the two (*Figs.* 5 and 6) whose arrangements are the most conspicuous.

In every case, moreover, the central group has, most probably, a spheroidal form, that cluster or nucleus having been derived from the central portion of its own spheroid; a portion whose form, as before shown, was such at the outset, and the wellnigh simultaneous rupture of which would still leave traces of the same.

The Milky Way — a Spiral.

The following coincidences are consistent with the supposition that the Milky Way and the stars within it together constitute a spiral with several (it may be *four*) branches, and a central (probably spheroidal) cluster; that which ought in such case to be observed being expressed in terms of that which has actually been seen.

If, then, the form of the Milky Way be really such as is here supposed, and our situation in the central cluster be, as it appears to be, "somewhat nearer to" the "northern surface,"[*] we should expect to find:—

1st. If the size of the stars in general approximates to a certain average, that those stars immediately surrounding us in the spheroidal and central cluster, as they are really nearer, and therefore brighter, would also appear larger; or that the careful "guaging of the heavens"[†] would lead, as it has, to the conclusion, "that the larger stars are really nearer to us (taken *en masse*, and without denying individual exceptions) than the smaller ones"; and also that, notwithstanding their crowded state in the Milky Way, there should be no "preponderance of considerable stars" there. (Quotations are from *Results of Astronomical Observations, &c. at the Cape of Good Hope*, p. 383.)

2d. In directions differing from the region of the Milky Way itself, we should find but few stars beyond a comparatively moderate limit; or that "the tendency to greater frequency, or the increase of density in respect of statistical distribution, in approaching the Milky Way," would be "quite imperceptible among stars of a higher magnitude" than that appropriate to such a limit; viz. "the 8th" magnitude. (Quotations are from *Results of Observations, &c.*, pp. 382, 383.)

3d. On looking through the spheroidal cluster, we should find that "the density of star-light (or the number of stars existing on an average of several" "enumerations in any one immediate neighborhood), is least in the pole of the *Galactic circle*, and increases on all sides with the *Galactic polar distance*, (and that nearly equally in all directions,) down to the Milky Way itself, where it attains its maximum"; and that *a law* of rapid increase might thus be detected, such as that found by Sir William Herschel and M. Struve in the northern, and Sir John Herschel in the southern hemisphere. (Sir John Herschel's *Outlines of Astronomy*, (793) . . . (796). See also *Philosophical Transactions*, Vol. LXXIV. (for 1784), p. 446; Struve's *Études d'Astronomie Stellaire*, Notes, p. 34; and *Results of Observations, &c. at the Cape of Good Hope*, Chap. IV.)

4th. Our position in the central cluster being on the side of the axis toward that part of the Milky Way which we see somewhat to the southward of the constellation *Orion*, a profusion of bright stars should be seen somewhat broadly projected on the sky in that region; insomuch, that, while "three or four of the brightest classes" of stars would be found to be "distributed with a considerable approach to impartiality over the sphere, a marked preference" might be "observable, especially in the southern hemisphere, to a zone or belt, following the direction of a great circle passing through ε *Orionis* and α *Crucis*." (Quotations are from Sir John Herschel's *Outlines of Astronomy*, (785).) To this the out-shooting of a spiral branch, which seems to have occurred there, may also in some measure have contributed.

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[*] *Phil. Trans.*, 1850, p. 510 and p. 504.

[†] *Ibid.*, p. 505.

[*] Sir John Herschel's conclusion from Sir William Herschel's researches and those of M. Struve, as well as his own. — *Outlines of Astronomy* (796).

[†] Sir William Herschel's well-known term.

5th. Many of the stars of the central cluster being derived from the central and highly heated portions of the primitive spheroid, some of them, at least, may when first separated have been nearly or quite in the nebulous state, and thus *the nebular hypothesis* have had place and been realized with respect to the solar system, and *nebulous stars* still be found in the central cluster, our own star (the sun) being included among them; * and a remnant of nebulous matter still be recognized in "that very extensive telescopic nebulosity," "which is" "expanded over more than sixty degrees of the heavens about the constellation of *Orion*; a luminous matter accounting much better for it than clustering stars at a distance." (Quotations are from Sir William Herschel's paper in the *Philosophical Transactions*, Vol. LXXXI. (for 1791), p. 84.)

[Most of the coincidences already stated are such as might exist, if the arrangement of the stars approximated to that which the careful "guaging of the heavens," by the distinguished astronomers already alluded to, has pointed out; but these coincidences are not such as seem imperatively to require a spiral form in the branches of the Milky Way; or even such as might be *far better* accounted for by the supposition that such branches exist, than by any other hypothesis. The discussion, however, of the special appearances presented by the portions of the Milky Way itself, when examined in detail, may serve to show that the supposed existence of such spiral branches, as a special part of the hypothesis now under consideration, is itself peculiarly in place, as accounting for many dissimilar, seemingly disconnected, and, in themselves, very peculiar appearances.]

6th. If we then suppose the structure of the spiral branches of the Milky Way to be in a great measure analogous to that actually existing in the case represented in *Fig.* 5, and that a broad fan-shaped stream or branch, like the inner one on the left, was projected toward that portion of the heavens which, as seen by us, extends from the constellation *Cygnus* to the region southward of *Orion*; that a second stream, represented by that below and toward the right of the figure, took nearly the direction of *Crux*; that a third stream, not wholly unlike that at the extreme right, was projected a little to the northward and eastward of that last described; and that a fourth stream, resembling the upper one in the figure, took the direction of *Sagittarius*; — then, from a position which would be marked in the figure as being below and to the left of the center, but, at the same time, really elevated *above* the general section of the four branches, — i. e., in accordance with the conclusion already quoted, "somewhat nearer to the northern surface" of the central cluster or nucleus, — from such a position as *that*, the various projections of the spiral branches might present in detail the following recognized appearances: —

(*a*.) Looking from our central position through the inner and comparatively faint branch of the spiral (represented on the left in the figure, and nearly in the horizontal direction, as there represented), we should see this branch projected upon the heavens, in the direction of the constellation *Cassiopeia*; and, continuing the view southward (i. e. in the representation, from the left, below, and so onward), we would first follow the projection of this same branch from *Cassiopeia* to *Monoceros*; and the branch itself being here not very dense, and mostly distant from us, its light would thus far appear "feeble and indefinite." An offshoot from it, comparatively near and *above* our position, might give us the branch of the Milky Way toward α *Persei*, "very conspicuous as far as that star," and "prolonged faintly" beyond it.

(*b*.) "Thenceforward" the Milky Way might "receive a gradual accession of brightness," by the interposition of the nearer, though less dense, portions of this branch of the spiral; and, from the partial crossing or overlapping of such, the part of the Milky Way passing "through the shoulder of *Monoceros* and over the head of *Canis Major*" might present "a broad, moderately bright, very uniform, and to the naked eye" possibly also "starless stream, up to the point where it enters the prow of the ship Argo"; — there being, as it would seem, a partial break, if not a vacuity, in a portion of this branch of the spiral, not very distant from our own position.

(*c*.) If the figure were an accurate representation of the Milky Way, the first branch of the spiral should probably terminate immediately below the center.

As the view approached this, a small branch might again be seen projected to one side; the "narrow winding" one extending "as far as γ *Argûs*."

(*d*.) The widely diffused and broken extremity of this branch of the spiral might also appear "broadly" projected, and "subdivide, opening out into a wide fan-like expanse," and exhibit, by cross projection, "interlacing branches," "all which" "might terminate abruptly in a line drawn nearly through λ and γ *Argûs*."

The rounded extremities of some of these branches, as represented in the engraving of this part of the Milky Way,* would also seem to indicate the existence of appendages like that in *Fig.* 6.

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* Sir William Herschel asks whether "faint nebulous branches joining to a nucleus" are not, "upon an immense scale, somewhat like what the zodiacal light is to our sun in miniature?" (*Phil. Trans. for* 1811, p. 311); and M. Arago insists upon the same thing. (*Annuaire pour l'An* 1842, pp. 406, 407.)

* *Results of Observations made at the Cape of Good Hope, &c.*, Plate XIII.

(*e.*) In the direction between the first and second branches of the spiral, it is evident, from the figure, that the Milky Way would be "interrupted by a wide gap."

(*f.*) Viewing next the second branch of the spiral nearly in the direction of a tangent to its greatest convexity, as the same appears in the figure, and at a place where also the *primary rents* in the stream might be seen nearly edgewise, we should see the Milky Way "recommence on the opposite side" of the gap, by a "fan-shaped assemblage of branches" such as "converge upon the bright star *η Argûs*"; * which might possibly be "more diffused, faint, and indefinite," than those preceding the gap.

(*g.*) The curvature of the second branch of the spiral would seem to be somewhat greater than that represented in the figure, since no distant portions are discernible either above or below the narrow part to which the "fan-shaped branches converge."

Looking next, then, from above and across the dense, near, fore-shortened, and yet curved origin of the second branch of the spiral, a "semicircular *concavity*" might be seen "*sharply defined*," on the *lower* side, "in the hind feet of the Centaur," and the Milky Way would indeed "enter the Cross by a very bright neck or isthmus"; all the circumstances which have been stated combining to render this "the narrowest portion of the Milky Way."

(*h.*) The explanation of the appearances noticed in (*g*) will be more satisfactory, if we suppose that part of the Milky Way to be *below* the general section. The general contour of the portion in this region is not inconsistent with such a supposition, and it seems to be required by the appearance of the part which immediately follows.

For we being *above the whole of the second branch of the spiral* as there exhibited to us, and it being at first *nearer* to us than the third branch, this portion of the second would be projected below the third. Afterward, the *third* being *nearer* and also *somewhat below* us, we should see the third below the second; and the one being thus projected across the other, and the primitive spheroid having been *deeply rent* in the formation of these branches, we discern between them that "singular dark pear-shaped vacancy," '*the coal-sack*'; the sharp point of which, still situated on the *hither* side, seems even now to give evidence of the rent. "Throughout all this region," the "brightness" must, moreover, be "very striking."

[The perturbations which must have existed under such circumstances — including the efforts at new axes of rotation — may readily enough account for the deviation *below* the general section of the Milky Way, which, as already stated, seems to exist here.]

(*i.*) Beyond the intersection of the two branches, an offshoot from the end of the second branch of the spiral, coming out from behind the third, might give the branch extending to *η* and *d Lupi*, soon losing "itself in a narrow and faint streamlet."

(*To be continued.*)

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* See again the engraving of this portion of the Milky Way already referred to.

OBSERVATIONS OF ENCKE'S COMET AND OF CLIO, MADE AT THE HAMBURG OBSERVATORY.

By **PROFESSOR CHARLES RÜMKER**, Director.

[Not corrected for parallax.]

ENCKE'S COMET.

	Hamburg M. T.	☄ α	☄ δ	No. Comp.
	h. m. s.			
1852, Jan. 20	6 43 6	348° 47′ 4″.0	+4° 50′ 2″.0	14
22	6 43 53.2	349 28 17.6	5 3 20.0	8
26	6 41 32.3	350 54 9.6	5 32 20.6	21
27	6 37 1.8	351 16 41.1	+5 39 23.4	3

CLIO.

	Hamburg M. T.	⑫ α	⑫ δ	No. Comp.
	h. m. s.			
1852, Jan. 21	9 52 33.3	114° 20′ 5″.6	+10° 12′ 43″.9	1
22	8 12 52.5	114 5 48.7	10 14 28.8	15
24	7 29 18.6	113 35 51.7	10 18 46.7	2
26	9 23 9.0	113 4 44.9	10 23 24.1	11
27	7 47 7.0	112 51 1.8	+10 25 41.2	1

OBSERVATIONS OF ENCKE'S COMET, MADE AT THE OBSERVATORY OF HARVARD COLLEGE.

	M. S. T. Cambridge.	Δα ☄ — *	No. of Obs.	Δδ ☄ — *	No. of Obs.	Star of Comp.
	h. m. s.	m. s.		′ ″		
1852, Jan. 13	6 57 28.46	+0 8.85	17	—2 2.9	6	*a*
17	7 2 16.71	+0 15.08	16	—3 32.9	10	*b*
19	7 24 35.76	—0 21.22	9	+3 32.5	6	*c*
20	6 54 5.46	—0 6.73	10	+3 35.4	6	*d*
23	7 20 35.57	—1 5.42	8	—3 38.3	5	*e*
Feb. 2	6 58 23.46	+0 35.04	12	+3 6.8	10	*f*
14	7 35 38.39	+1 34.51	8	+2 50.0	6	*g*

Stars of Comparison referred to the Mean Equinox of January 1st, 1852.

Star.	α	δ	Mag.	Authority.
	h. m. s.	° ′ ″		
a	23 6 29.23	+4 11 34.6	8	Weisse XXIII. 111.
b	11 18.36	4 36 3.3	8.9	Compared with B. A. C. 8127.
c	14 31.28	4 41 39.9	10	" " "
d	15 34.75	4 47 57.4		" " "
c	20 44.02	5 15 39.6	8	Weisse XXIII. 413.
f	34 24.43	6 25 51.9	6.7	" 710.
g	23 51 49.65	+8 7 57.3	9.10	" 1132.

ENCKE'S COMET.

	M. S. T. Cambridge.	α 1852.0	δ 1852.0
	h. m. s.	h. m. s.	° ′ ″
1852, Jan. 13	6 57 28.46	23 6 38.08	+4 9 31.6
17	7 2 16.71	11 33.44	4 32 30.3
19	7 24 35.76	14 10.06	4 45 12.4
20	6 54 5.46	15 28.02	4 51 32.8
23	7 20 35.57	19 38.60	5 12 1.3
Feb. 2	6 58 23.46	34 59.47	6 29 1.3
4	7 35 38.39	23 56 24.16	+8 10 47.3

W. C. BOND.

1852, *March* 13.

MISSING STAR.

On the morning of September 24th, Mr. C. W. Tuttle noted the place of a star of the 10th magnitude by a diagram with neighboring stars, for the purpose of identifying the stars of comparison used on that morning for D'Arrest's Comet. Its place was, September 24th, 16ʰ· 54ᵐ·, —

R.A. 4ʰ· 23ᵐ· 44ˢ· } Equinox, 1851.0.
Decl. —2° 14′ 28″ }

The same region was examined on the following morning, and again some days later, but the above was wanting. As its place had been fixed by reference to a pair of stars of equal size in the same field, and three others following by 40ˢ· or 50ˢ· in right-ascension, there is little chance for mistake as to its locality, which was besides recognized by the circle-readings approximately.

W. C. BOND.

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ON THE ORIGIN OF THE FORMS AND THE PRESENT CONDITION OF SOME OF THE CLUSTERS OF STARS AND SEVERAL OF THE NEBULÆ.

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PROFESSOR OF MATHEMATICS AND ASTRONOMY IN THE COLLEGE OF NEW JERSEY.

(*Continued from page* 103.)

(*k.*) After this, the fourth branch of the spiral (represented at the top of the figure) might begin to show itself, very much as the second branch made *its* appearance, as before described in (*f*). Here also we see in Sir John Herschel's representation (*Results of Observations at the Cape, &c.*, Plate XIII.) a repetition, on a smaller scale, of the "fan-shaped assemblage of branches" which appeared in the former instance. In this instance, however, the phenomena indicate that these "branches" are more remote, and they appear, as already stated, *smaller:* their convergency, withal, is from a position *above* the general section of the main branch of the Milky Way, as though a portion of the fourth branch of the spiral were thus elevated near to its origin. Such a supposition would, besides, go far toward rendering an account of that "abrupt elbow" which occurs, a little before this, "at *γ Normæ*"; the bend of the elbow being, moreover, in the appropriate direction.

(*l.*) Above this last arrangement, the *outer* portion of the third branch of the spiral, seen crosswise, might contribute to "a complicated system of interlaced streaks and masses" which "terminates in a vast and faint effusion." The upturned portions of the "fan-shaped assemblage" described in (*k*) would seem to furnish the greater part of this "system"; including the "strong offsets" "like a bridge" connecting the two "streams."

(*m.*) Beyond this, the fourth branch of the spiral, though at first upturned, would speedily pass toward its descending node *behind* the first branch; the first branch being the nearer to us, and very obliquely projected across the fourth.

Where the one is about passing behind, there occurs, it may be, that abrupt bend of the "main stream" which we see as "it passes over the stars *ι Aræ*, *θ* and *ι Scorpii*, and *γ Tubi*."

After this we would look through the *most dense*, and not very distant portion of the fourth branch of the spiral, and almost in the *very direction* in which it is projected from the central cluster; a combination of circumstances which ought to give an unparalleled richness to this portion of the Milky Way, should there even be no overlapping of the first branch of the spiral.

We need not therefore be surprised to find that in the region near "to *γ Sagittarii*," the Milky Way "*suddenly collects* into a *vivid oval mass*, about six degrees in length and four degrees in breadth, *so excessively rich* in stars that a very moderate calculation makes their *number exceed* 100,000."

(*n.*) Northward of this, the combined projection of the first and fourth branches of the spiral, alluded to in (*m*), would be very "conspicuous"; and clustering appendages similar to that represented in *Fig.* 6 would seem to be attached to one or to both branches.

For, "northward" of the "mass" last described, "this stream crosses the ecliptic," "and, proceeding along the bow of *Sagittarius* into *Antinous*, has its course rippled by three deep concavities, separated from each other by *remarkable protuberances*, of which the larger and brighter (situated between Flamstead's stars 3 and 6 *Aquilæ*) forms the most conspicuous patch in the southern portion of the Milky Way visible in our latitudes" (i. e. those of Great Britain), and the like is true in our own.

(*o.*) Beyond this, the crosswise projection of two more distant portions of the two branches of the spiral would show us the "irregular, patchy, and winding stream through *Aquila*, *Sagitta*, and *Vulpecula* up to *Cygnus*."

(*p.*) This last position being, as it would seem, beyond the node of the two spiral branches, and they both quite distant, and probably also much broken and rent, the "continuity" of the Milky Way is here "interrupted, and a very confused and irregular region commences, marked by a broad, dark vacuity, not unlike the southern coal-sack."

(*q.*) These diverging spiral branches, lastly, seem to furnish three other branches of the Milky Way. Portions of both may perhaps be still apparent in the "stream" which is a continuation of (*a*) beyond "the interval" described in (*p*); viz. "from *α Cygni*," "northward between *Lacerta* and the head of *Cepheus* to the point in *Cassiopeia* whence we set out" in (*a*).

Another portion is seen "branching off from *γ Cygni*, very vivid and conspicuous, running off in a southern direction through *β Cygni* and *s Aquilæ* almost to the equinoctial, where it loses itself in a region thinly sprinkled with stars."

This seems to be the projection of the *upper* portion of the nearer and quite dense part of the first branch of the spiral, seen from our lower position, and projected above the descending fourth branch; the further projection of this upper portion being arrested by a long break or rent,[*] leaving only the remnants which are seen in the "region thinly sprinkled with stars."

In so far as its projection upon the heavens could be a guide, "this is the branch which, if continued across the equinoctial, might be supposed to unite with the great southern effusion already noticed" in (*l*); "but a wide interval of 14°, free from all appearance of nebulous light," separates the two: all which is fully in accordance with what is here supposed.

To this same branch of the spiral must also be attributed the third "considerable offset or protuberant appendage" "thrown off by the northern stream from the head of *Cepheus* directly towards the pole."

(*r.*) The crosswise projection of wide though distant portions of *both* branches of the spiral, will account for the great average breadth of the Milky Way in the region extending from *Cygnus* to *Cassiopeia.*

In addition to these *special* coincidences, or instances of the agreement of phenomena with the hypothesis, apparent in "the course of the Milky Way as traced through the heavens by the unaided eye,"[†] there are several others which seem to deserve a separate place in the general arrangement. Among these is, —

7th. The existence of appended clusters.

The noted clusters in *Perseus* present instances of a protuberance, whose character is very manifest even without the aid of a telescope; and with the aid of that instrument, SIR WILLIAM HERSCHEL has enumerated "twenty clusters of stars, fifteen in the Milky Way"; "eighty irregular clusters of stars, of various unascertained sizes, fifty-three in the Milky Way; and thirty-two irregular clusters from 2′ to 30′ in diameter, twenty-two in the Milky Way."[*]

In addition to this, SIR JOHN HERSCHEL distinctly states, that "one of the most remarkable features in the southern nebulous system is the extraordinary display of fine resolved and resolvable clusters which occurs between $16^{\mathrm{h.}}\,45^{\mathrm{m.}}$ and $19^{\mathrm{h.}}$ in right-ascension in the region occupied by *Corona Australis*, the body and head of *Sagittarius*, the tail of *Scorpio*, with part of *Telescopium* and *Ara*"; — and he, among other things, proposes the question, whether we are "to connect" this "with the very peculiar structure of the Milky Way in this particular part of its course, which is here unlike in its constitution to any other portion of that zone" (see description already given), "and which passes diametrically across the" "area in question."[†]

Of the "northern portion of the stream" indicated at (*l*) in the particular description, he remarks, "This branch is thickly set with fine globular clusters, *all of which* occur within its starry area, *and none in the* dark region intervening between the streams."[‡]

He, moreover, signalizes Nos. 3690, 3720, and 3723 as affording wellnigh indubitable evidence "that some, at least, of these objects belong to and form a part of the Milky Way."[†]

8th. In the very conspicuous portion of the Milky Way distinctly noticed at (*n*) in the particular description, the enormous *rents* or *breaks* in the material of the *primitive spheroid* seem, even now, to be very manifest.

9th. Telescopic observations afford distinct evidence of the existence of remote outlying branches of the Milky Way.

Thus SIR WILLIAM HERSCHEL particularizes "ten observations" in the course of which the gauges applied to the Milky Way were found to be arrested in their progress by the extreme smallness and faintness of the stars; but adds: "This, however, can leave no doubt of the progressive extent of the starry regions; for when in one of the observations a faint nebulosity was suspected, the application of a higher magnifying power evinced that the doubtful appearance was owing to an intermixture of many stars that were too minute to be distinctly perceived with a lower power; hence we may conclude, that, when our gauges will no longer resolve the Milky Way into stars, it is not because its nature is ambiguous, but because it is fathomless."[§]

Five of the positions at which this phenomenon was observed were at, or a little beyond, "the broad, dark vacuity" mentioned in (*p*); where the distant portions of the fourth and first branch of the spiral were supposed to project across each other; two were in the feeble and probably distant portion described in (*a*) and (*b*); and the remaining three in the region described in (*o*); where also it was supposed that the fourth branch had passed behind the first.

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[*] Occurring when the fourth branch was bent down.

[†] This quotation, and those relative to the apparent course of the Milky Way which precede it, are from SIR JOHN HERSCHEL'S minute and careful descriptions (*Outlines of Astronomy*, (787) – (791)), and *Results of Observations, &c. at the Cape*, Chap. IV. Sect. II.; several phrases, however, have been italicized, because of their special bearing upon the explanations here given.

[*] Notes to pp. 265 and 267 of *Philosophical Transactions for* 1814.

[†] *Results of Observations made at the Cape of Good Hope, &c.*, p. 136.

[‡] *Results of Observations, &c.*, p. 387.

[§] *Philosophical Transactions for the Year* 1818, p. 463; and the Vol. for 1817, pp. 325, 326, and 329.

Sir John Herschel also describes several extensive regions of "Nebulous Milky Way," and ascribes the appearance to our seeing "foreshortened a vast and illimitable area scattered over with discontinuous masses and aggregates of stars in the manner of cumuli of a mackerel sky, rather than a stratum of regular thickness and homogeneous formation; and that in the inclosed spaces, insulated from the rest of the heavens by the preceding and following streams, and the 'bridges' above spoken of" [in (*l*)] as connecting them, (as, for instance, in that which includes λ *Scorpii*,) we are, in fact, looking out into space through vast chimney-form or tubular vacancies, whose terminations are rendered nebulous by the effect of their excessive distance, and at the same time are brought by that of perspective to constitute the interior borders of the apparent vacuities." *

He mentions, moreover, another phenomenon, as affording perhaps "some indications of very remote telescopic branches of the Milky Way"; viz. "an exceedingly delicate and uniform dotting or stippling of the field of view by points of light too small to admit of any one being steadily and fixedly viewed, and too numerous to count them, were it possible so to view them." He speaks also of "starless space, and light in the field without stars enough to account for it." *

The existence of branches, one far behind the other, is also clearly brought out in *this* manner: — "In other regions we are presented with the phenomenon of an almost uniform degree of brightness of the individual stars, accompanied with a very even distribution of them over the ground of the heavens, both the larger and smaller magnitudes being strikingly deficient. In such cases it is" "impossible not to perceive that we are looking *through* a sheet of stars nearly of a size, and no great thickness compared with the distance which separates them from us. Were it otherwise, we should be driven to suppose the more distant stars uniformly the larger, so as to compensate by their greater distance, a supposition contrary to all probability. In others, again, and that not unfrequently, we are presented with a double phenomenon of the same kind; viz. a tissue, as it were, of large stars spread over another of very small ones, the intermediate magnitudes being wanting. The conclusion here seems equally evident, that in such cases we look through two sidereal sheets separated by a starless interval." †

10th. Another circumstance indicative of our central position in our own cluster may be found in the presence of *red* stars immediately around us.

Among the very first of the coincidences already noticed was the fact that the visibly larger stars are, in general, the nearer; and among the really few regarded as of the first magnitude, quite a number are red, or of a color approaching to red; and among the small number proved to be comparatively near, as they have shown a sensible parallax, *Arcturus*, *Capella*, and (to some extent) even *Polaris* have all a ruddy tint; and the same description is especially applicable to both the components of the double star α *Centauri*, the nearest of them all.

Now, "it is no uncommon thing to find a very red star, much brighter than the rest, occupying a conspicuous situation" in a cluster; and "ruby stars often occur" there.*

In Sir John Herschel's Northern Catalogue this peculiarity is noted in the instances of Nos. 145, 212, 350, 443, 2124, and 2154; and in his Southern Catalogue, in 2322, 3111, 3315, 3435, 3573, 3654, and 3753 respectively. Of these, Nos. 212 and 443 are in the Milky Way.

Double stars in clusters are also spoken of in the instances of 2127, 2285, and 2292; while 2003 has a triple star in it; and 3111 "has two or three neat double stars in it," besides the "orange-colored star of the 8th magnitude in the middle." This is "a large and magnificent cluster of perhaps 200 or 250 stars 8 . . . 16 m."

In 3753 "the stars are of two magnitudes," "the largest" "visibly reddish"; of 3435 it is said, "The very different colors of the constituent stars give it the effect of a rich piece of fancy jewelry"; and 2322 is the magnificent cluster 47 *Toucani* (of Bode's Catalogue). It has "a central blaze whose diameter in right-ascension is $13^s.5$, and whose color is ruddy or orange-yellow, which contrasts evidently with the white light of the rest." †

[11th. In so far as the facts last stated may indicate it, — it might seem as if ruddy light existed in the region of greater density.

May not then *that*, and *the hypothesis of the spheroidal origin* of our cluster, together indicate also *the origin of the numerous binary stars; why so many of them are colored, and why their colors are complementary; and whence they severally derive their motions about their common centers of gravity?* The elongated fragments of the primitive spheroid might be so situated as to assume something like the unstable form of equilibrium of an ellipsoid with *three unequal axes*, itself an approximation to a cylinder with rounded ends. The rupture of such fragments might take place in the manner *imitated* in the experiments of M. Plateau, by the breaking of a liquid cylinder too long for its diameter; viz. into large spheres with much smaller ones between them: in this case, into very unequal multiple stars. ‡

With or without all this, — if, as heretofore suggested, something analogous to a chemical change of state should supervene, and separation into *unequally dense* arrangements should therefore occur; then, the difference of inertia of these last, and possibly also causes of repulsion then become efficient, might cause a separation of the still *projected* fragment into two or more portions, — more commonly, as it would seem into two; the greater and probably more dense of the ultimate fragments exhibiting its appropriate *ruddy* tint, and the smaller exhibiting very possibly also (though not *of course*) the complementary color: since it still would consist of the material which together with that in the larger star had before given a white light.

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* *Results of Observations, &c.*, pp. 388, 389, 390; see also Sir John's remarks on the character of the phenomenon, on the page last mentioned, and Plate V. Fig. 1 of the same volume.

† Sir John Herschel's *Outlines of Astronomy* (797).

* Sir John Herschel's *Outlines of Astronomy* (869), and *Remark* at 2154 of his Northern Catalogue (*Phil. Trans. for the Year* 1833, p. 472).

† *Results of Observations made at the Cape of Good Hope, &c*, pp. 17 and 51.

‡ For a further explanation of such changes see remarks introductory to Class IV., to *Complex Nebulæ*, and to Class III., respectively.

A rotation of the two or more stars about their common center of gravity would be all but inevitable, as the resultant of the oblique forces thus brought into action.

The analogy may possibly be very remote indeed, — and yet similar changes of density with their appropriate varieties of tint, seem to take place in the *exceedingly rare material* which produces the aurora borealis, when the display of the phenomenon is *very vivid.*

May not, moreover, the actual rending of *Biela's* (*Gambart's*) *Comet*, at its last return, have been brought about by the action of causes analogous to those here supposed to have been efficient in the case of far greater masses?[*]]

12th. The proper motions of the stars of our cluster may also be accounted for on the hypothesis of their common spheroidal origin; the motion of the solar system being in the direction toward the constellation *Hercules*, in accordance with the determinations of Sir William Herschel and Mr. Prevost, and those of Messrs. Argelander, Lundahl, O Struve, Peters, and Galloway; and the situation in the cluster that which is required alike by the direction of the sun's proper motion, the proximity of some of the constellations, and of the visible southern branches of the Milky Way, and the *bend* of all the supposed spiral appendages; viz. the position assigned at the outset of the comparison here made.

The proper motion of the solar system may be presumed to be comparatively slow, we being near to the axis of the primitive spheroid: and such is the probable result indicated by the determination of Messrs. Argelander, O. Struve, and Peters.[†]

The whole group, however, cannot be considered as having acquired a state of *dynamical* equilibrium, — *that* having been destroyed when the primitive spheroid was first rent, — but the divided portions constituting the stars of our group are yet, it may be, in a condition of continued dispersion.

If this be so, the mass must most probably be different from Dr. Mädler's result, obtained upon the hypothesis that a dynamical equilibrium has place: while the axis of rotation, or that which may be regarded as such, need no longer be at right angles to the general section of the Milky Way as it now exists; whatever else may be concluded as to the reliability of such results as those obtained by Dr. Mädler, in the present state of our knowledge.[*]

It will be observed, that the decision of the question of the resemblance of the Milky Way to the spiral forms discovered and described by Lord Rosse, or the contrary, does not, of course, involve that of the truth or falsehood of the hypothesis of the spheroidal origin, as here proposed; although more phenomena seem to be in place, if that hypothesis be admitted.[†]

In addition to the spiral forms already specified, the following are mentioned in the first part of Lord Rosse's *List of some remarkable Nebulæ.* This portion includes those which appeared to him to be spiral or curvilinear. The forms of some of them are probably complex, and resemble those to be noticed hereafter.

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[*] All that is here said relative to the binary stars is offered as a conjecture merely with reference to a very curious subject; and yet as furnishing coincidences singularly in place as consequences of the spheroidal origin of our cluster.

Sir William Herschel suggests the analogy of the light derived from the solar envelope to that which we see in the aurora borealis, (*Phil. Trans. for* 1794, p. 62); and Sir John Herschel, indorsing that view, also, as a matter of conjecture, speaks of "vast currents of electricity" as the cause which may "render" "matter radiant" "in the higher regions" of "the atmospheres" of the sun and stars, "after the manner of our own aurora borealis, under the influence of terrestrial electric streams." (*Results of Observations, &c.*, p. 351)

[†] F. G. W. Struve, *Études d'Astronomie Stellaire*, p. 108.

[*] See Dr. Mädler's conclusions (*Astronomische Nachrichten*, No. 567); the criticism of Dr. Peters (*Bulletin de la Classe physico-math. de l'Académie des Sciences de St.-Pétersbourg*, Tom. VII. Nos. 12, 13), as quoted by Dr. Mädler, and Dr. Mädler's reply (*Astr. Nachr.*, No. 674); also Sir John Herschel's remarks (*Outlines of Astronomy*, (861)).

[†] The resemblance of the Milky Way to *these* spirals does not seem to have been heretofore suggested, and certainly not a similar origin of them all; yet, aside from the results of the valuable researches with regard to the form of the Milky Way already alluded to, some other peculiarities have been pointed out. Thus, Sir William Herschel speaks of the Milky Way as having "the shape of a crookedly branching nebula" (*Phil. Trans. for* 1785, p. 219), and Sir John Herschel says: —

"Probability may, it is true, here and there enlighten us as to certain features. Thus when we see, as in the coal-sack, a sharply defined oval space free from stars, insulated in the midst of a uniform band of not much more than twice its breadth, it would seem much less probable that a conical or tubular hollow traverses the whole of a starry stratum, continuously extended from the eye outwards, than that a *distant* mass of comparatively moderate thickness should be simply perforated from side to side, or that an oval vacuity should be seen foreshortened in a *distant* foreshortened area, not really exceeding two or three times its own breadth. Neither can we without obvious improbability refuse to admit that the long lateral offsets, which at so many places quit the main stream and run out to great distances, are either planes seen edgeways, or the convexities of curved surfaces viewed tangentially, rather than cylindrical or columnar excrescences bristling up obliquely from the general level. And in the same spirit of probable surmise, we may account for the intricate reticulations above described as existing in the region of *Scorpio*, rather by the accidental crossing of streaks thus originating, at very different distances, or by a cellular structure of the mass, than by real intersections. Those cirrous clouds which are often seen in windy weather convey no inapt impression either of the kind of appearance in question, or of the structure it suggests." (*Outlines of Astronomy*, (792).)

The coincidences between these deductions, and those — partly theoretical — already exhibited, are sufficiently evident.

"H. 142, 262, 327, 695, 749, 910, 1002, 1211, 1312, 1368, 1451, 1570, 1776, 2172."*

The central portion of H. 131, represented by LORD ROSSE (*Philosophical Transactions for* 1850, Plate XXXVI. Fig. 5), has also four extended and curved branches; "but as yet no other portion appears to have a spiral, or indeed any regular arrangement."†

The figure of H. 881, as represented by SIR WILLIAM HERSCHEL (*Philosophical Transactions for* 1811, Plate IV. Fig. 20), has some resemblance to this last.

Possibly it may also resemble H. 516, which is described in the catalogue as being "shaped like a flattened X."‡

From the description 639 of the same catalogue, *it* would seem to resemble H. 2370, already alluded to, and represented in *Fig.* 7. H. 368 is spoken of as "whisp-shaped."

Order 2d. Elliptic Nebulæ.

In accordance with the theoretical investigation already exhibited, a slower rotation of the primitive spheroid than that supposed in any of the instances already considered, would be consistent with a much greater oblateness of figure.

Under such circumstances, the cooling effect of radiation would be very great, and cohesion might *increase* rapidly. The contraction of the thin portion of the spheroid, extending far out in the direction of the equatorial regions, might then be in a great measure proportionate to the rapidity of radiation; yet the dynamical equilibrium might, after all, remain for a long time so far undisturbed, that no rending of the spheroid would occur: the centrifugal force of rotation having been very feeble at the outset, and, though increased in no inconsiderable *ratio* by the contraction of the mass so rapidly cooled, and aided by other repulsive forces, yet still insufficient to overcome the *increased* cohesion.

The "nebular hypothesis" might then be realized on an enormous scale, in the abandonment of a vast equatorial ring, which would seize upon the thin portion on both sides of its plane with an almost uncontrolled attractive force; and the portions of the mass thus brought more closely together would suffer little or no change of velocity, their distances from the axis remaining very nearly the same.

There being, moreover, but little resistance from the centrifugal force, the *condensation* of the central portion of the spheroid might, in process of time, become considerable, this central portion having *less oblateness* than that which belonged to the abandoned equatorial region.

The contraction, and with it the acceleration of *angular* velocity of the condensed central portion, might then proceed, until a catastrophe ensued, similar to that already described in the case of spiral nebulæ and clusters; or the material of the central spheroid may have been scattered by a wellnigh simultaneous rupture of the whole; which would give rise to other forms, to be considered hereafter.

Accordingly we find, that while elliptic nebulæ admit of "every law of condensation from the circumference to the center of the apparent outline, from a uniform disc to a star-like center, surrounded with a faint and gradually fading nebulosity"; "another feature, common to all the nebulæ of this class, is the diminution observable in the ellipticity of their strata from without inwards, so as to approach to a spherical nucleus, however elongated their extreme elliptic outline."*

Fig. 9 represents a "remarkable specimen" of such a nebula, in which "the condensation" is described as being "great and sudden; so sudden, indeed, as to offer the appearance of a dull and blotted star standing in the midst of a faint, nearly equable elliptic nebulosity."† The figure is a copy of that given by SIR JOHN HERSCHEL (*Phil. Trans. for* 1833, Plate XIV. Fig. 55), and represents H. 1175.

Another decided instance of the same sort is found in H. 3523, which is represented in Plate IV. (Fig. 5) of *Results of Observations at the Cape, &c.* "In both cases the nucleus appears to contain within it a still smaller round kernel."‡

Fig. 10 is copied from LORD ROSSE's representation of H. 854 (*Phil. Trans. for* 1850, Plate XXXVII. Fig. 7). This object is described as being "a curious nebula with a bright nucleus; resolvable; a spiral annular arrangement about it; no other portion of the nebula resolved."§

LORD ROSSE remarks, that "the appearance" of it "suggests the idea of an elliptic annular system seen very obliquely. A series of very elliptic shells enveloping the nucleus, seen somewhat obliquely, would perhaps also present the same aspect."‖

The "elliptic annular system" here supposed would rather seem to be a *circular* one; since *that* would appear elliptic if seen obliquely; and the form of *the spiral*, flattened as it is in the direction of the shorter axis of the "annular system," is not inconsistent with such a supposition. We should then *actually* have an appearance such as might be presented by the fragments of rings abandoned by the central portion of the primitive spheroid, and also the spiral arrangement of the central portion, resulting from the catastrophe already supposed.

It is scarcely supposable that the *dynamical* equilibrium of the rings could in any instance be ultimately maintained. The difficulties in the way of such a result, even in the recognized case of the rings of *Saturn*, have been exhibited by Mr. G. P. BOND and Professor PEIRCE; and the astronomer last mentioned has also indicated the singular adjustment by which the equilibrium of the rings is maintained.¶

Viewed in the light of "the *nebular hypothesis*," the case of the asteroids has been an exception in the *solar system;* the ring having broken into many fragments: while the case of the accumulation of the ring into a single planet has been the rule.[*] In the clusters, on the contrary, the minute subdivision of the ring would seem to have been the ordinary result; with possibly exceptions in which but one, or, at most, a very few stars were formed from such a ring.

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* *Phil. Trans. for* 1850, p. 514.

† *Ibid.*, p. 512

‡ *Phil. Trans. for* 1833, p. 387.

* *Results of Observations at the Cape of Good Hope, &c.*, p. 140.

† SIR JOHN HERSCHEL's *Outlines of Astronomy* (873).

‡ *Results of Observations at the Cape, &c.*, p. 21.

§ *Phil. Trans. for* 1850, p. 512.

‖ *Ibid.*, p. 508.

¶ *Astronomical Journal*, Nos. 25, 26, and 27.

This conclusion would seem, in the first place, to be in accordance with the fact, that the "resolvability" of elliptic nebulæ "is greater in the central parts, whether owing to a real superiority of size in the central stars, or to the greater frequency of cases of close juxtaposition of individuals, so that two or three united appear as one."[†]

This would be altogether in place, if the small stars toward the outside of the elliptic cluster were the fragments of a thin ring or rings, and the stars within were the dissevered portions of the central part of the primitive spheroid.

That, in the second place, one or at most a very few stars may have resulted from the rupture of a ring, might seem to be indicated by the existence of such stars as companions of elliptic nebulæ; such as appear in the *Results of Observations at the Cape, &c.* (Plate IV. Fig. 5), and the first of the associated nebulæ represented in Fig. 3 of Plate III. of the same work; but in these instances the *double* stars are very probably only *optically* adjacent to their respective nebulæ; and very possibly also nearer to us: but the supposition of the *annular* origin of such stars is much more probable in the case of the "satellites" of *planetary* nebulæ; the peculiarities of which deserve to be separately considered in their proper place.

Fig. 14 is copied from Mr. GEORGE P. BOND's representation of the great nebula in *Andromeda*, H. 50, M. 31, (at p. 86 of the *Memoirs of the American Academy*, Vol. III., New Series,) as seen in the great refractor of the Cambridge Observatory, Mass. In this, the deviation from the elliptical form toward one side seems almost to indicate a spiral arrangement seen at a very great distance. The "dark bands or canals" described by Mr. BOND and represented in the figure would then be in the situation of *rents* in the *primitive* spheroid, their *angular* opening withal being in the *direction* required by the loss of angular velocity occasioned by the *dragging behind* of the ejected spiral; *rents* not unlike those already supposed, in the description of the successive changes, the result of which was the nebula represented in *Fig.* 5; with which the Milky Way was afterwards compared.

Besides these, we also discern in *Fig.* 14 appendages not unlike to those attached to the recognized spiral represented in *Fig.* 6.

All this, however, though seemingly in place, can scarcely be regarded as other than conjectural with respect to an object whose details can hardly be discerned, with even the best telescopes yet constructed.

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[*] LAPLACE, *Exposition du Système du Monde*, 5^e edition, p. 438.

[†] SIR JOHN HERSCHEL's *Outlines of Astronomy* (873).

Fig. 10 *bis* is copied from LORD ROSSE's figure in the *Phil. Trans. for* 1850 (Plate XXXVII. Fig. 14). It represents H. 2098, a *planetary* nebula; "in which," says LORD ROSSE, "we have not detected any perforation" (as he had in others), "but it has ansæ, which probably indicate a surrounding nebulous ring seen edgeways."[*]

An inspection of the figure seems also to indicate the rupture of the spherical or spheroidal mass in the center, in accordance with all that has already been pointed out as resulting from the hypothesis of a spheroidal origin.

Another remarkable example of an elliptic nebula is H. 61, which was discovered by MISS CAROLINE HERSCHEL. SIR JOHN HERSCHEL has given a representation of it (*Phil. Trans. for* 1833, Plate XIV. Fig. 52). This nebula, like the other in *Andromeda* already noticed, is of a very great size. Neither of these two great nebulæ seem to have been as yet resolved. Mr. BOND says of that figured and described by him, — "With high powers minute stars are discovered on the borders of the nucleus, but it has thus far yielded no evidence of resolution. About fifty stars are visible in the same field with it; no other equal space occurs within the limits of the nebula containing so few."[†]

The like seems also to be true of the other one.[‡] It is, indeed, a well-founded induction, that elliptic nebulæ "are, for the most part, beyond comparison more difficult of resolution than those of globular form"; although, as stated in a part of the same passage heretofore quoted, "their resolvability" "is greater in their central parts."[§]

The *central* portions of H. 854, shown in *Fig.* 10, did indeed yield to the power of LORD ROSSE's large reflector, but, as stated in a passage already quoted, "no other portion of the nebula was resolved."[||]

It becomes, then, an interesting question, whether the ring abandoned by the primitive spheroid, or some of its fragments, may not still be in the nebular state?

True, as heretofore stated, the preservation of the nebular ring would be attended with difficulty, and the ring as such might endure for a *comparatively* short time; yet, under these circumstances of wide dispersion and excessively slow rotation, the time thus *short* in comparison with the periods occupied by the other changes in question, might be *long* in comparison with *ordinary standards.*

It seems, moreover, to be worthy of notice, in this connection, that the annular form is that assigned by DOMINIC CASSINI, LAPLACE, SCHUBERT, and POISSON to the exterior portion of the very rare material surrounding the sun's equator, to which we owe the *zodiacal light.*[¶]

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[*] *Phil. Trans. for* 1850, p. 507.

[†] *Memoirs of the American Academy*, Vol III., New Series, p. 82.

[‡] *Results of Observations, &c*, note to p. 18.

[§] SIR JOHN HERSCHEL's *Outlines of Astronomy*, (873).

[||] H. 357 (*Phil. Trans. for* 1833, Plate XVI. Fig. 81) has been resolved by LORD ROSSE (*Results of Observations, &c.*, note to p. 18).

[¶] As quoted by HUMBOLDT, *Cosmos*, Vol. I. note (96).

CLASS II.

(Primitive Form a Spheroid of comparatively small Ellipticity.)

Order 1st. Spheroidal Clusters and Nebulæ.

When the oblateness of the primitive spheroid was comparatively inconsiderable, the exposure of surface being much less than it would have been in the cases already considered, the effects of radiation might well employ a longer time, especially if the spheroid were of unusual size; the surfaces of such spheroids, when similar, increasing with their dimensions, but in a less ratio than their volumes.

But although, therefore, the cooling effect of radiation would most probably itself be less, and less rapidly developed, yet the form in question would require a more rapid rotation at the outset, unless the deviation from a sphere were *excessively* small, which is not here supposed; and this more rapid rotation would also imply an increased centrifugal force at the same distance; that force at a given distance varying as v^2, v being the actual velocity.

Greater central condensation and pressure are also supposable under such circumstances, from the long continued action of centripetal force; i. e. in so far as the internal temperature and elastic forces in general of the enormous mass would permit.

In so far, moreover, as mass and rotation only were concerned, the ratio of the centripetal and centrifugal forces would approximate to that in a homogeneous spheroid; i. e. (as estimated in circles at right angles to the axis) the ratio would be the same at all points;[*] and where increased central condensation would imply increased centripetal power, increased elasticity would also, in all probability, exist to some extent to counteract it.

The *divellent* force tending to an equatorial accumulation, as before, might not, however, be wholly inactive; but as the conservative tendencies might all very well be more efficient in this case, the increased cohesion arising from long cooling of the superficial region, and a more efficient central action, might together prevent a catastrophe for an enormous period.

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[*] For, in the *same* spheroid, the *centripetal* force, in the direction perpendicular to the axis, would vary as the distance from the axis itself (see AIRY's *Math. Tracts*, 3d edition, p. 134); and the *angular* velocity being everywhere the same, the like would be true of the *centrifugal* force; as was shown at the outset of this investigation.

(To be continued.)

The plates to Professor ALEXANDER's article will accompany the next number. — G.

ELEMENTS OF EUNOMIA,

BY T. H. SAFFORD, JR.

Computed from normal places, 1851, August 10, October 25; 1852, January 9.

1851, October 25, M. T. Greenwich. — Mean Equinox.

M	298° 41′ 11″.6
☊	293 54 39.9
ω	94 16 46.1
i	11 43 56.9
ϕ	10 47 22.0
μ	13 47.537

For the middle observation, $\Delta\lambda \cos\beta$ (C. — O.) $= -0''.5$; $\Delta\beta\ -0''.1$.

NEW PLANET.

DR. PETERSEN issued a circular, April 6, announcing the discovery of another asteroid by Professor DE GASPARIS in Naples. The following are the apparent positions given by the discoverer, — who compares its brilliancy to that of a star of the 10.11 magnitude.

	M. T Naples. h. m. s.	⑯ α h. m. s.	⑯ δ ° ′ ″	No. Comp.
1852, March 17	9 52 32.5	9 57 56.7	+12 51 20	2
19	8 20 18.9	56 54.2	12 58 19	7
20	9 25 27.1	56 21.2	13 1 41	2
21	7 48 48.0	55 51.3	13 4 56	1
22	7 58 37.3	9 55 25.1	+13 8 16	6

DR. PETERSEN informs me that he searched for the new planet on the evening of April 5, but in the bright moonlight was unable to detect it.

1852, *April* 23. G.

APPEARANCE OF THE RING OF SATURN, 1851.

By G. P. Bond,

Assistant at the Observatory of Harvard University.

The past year has presented another well-authenticated instance of extraordinary divisions in the ring of *Saturn*.

A division in the exterior ring was seen by the Rev. W. R. Dawes of Wateringbury, England, and a few weeks later by Messrs. Fletcher and Pattinson of Newcastle-upon-Tyne. It was seen also in the same month by Mr. Alvan Clark of this city. Messrs. Dawes and Clark have had the kindness to transmit to us their drawings of the position of the dark line upon the outer ring. Both place the dark line nearest to the outer edge of the ring, agreeing in this particular with Mr. Fletcher's account (*Monthly Notices Astr. Soc.*, Vol. XII. pp. 11 – 14).

A very remarkable appearance of multiple divisions was seen recently at this Observatory upon the inner ring (the old inner ring, not the new dark ring), by W. C. Bond, C. W. Tuttle, and R. F. Bond, with the great refractor. Confirming in a most satisfactory manner the account given by Mr. Dawes in the *Monthly Notices*, Vol. XII. p. 11, of what was observed by him within the very same week.

It is a phenomenon of the same nature with that described by Professor Encke and Dr. Galle in 1837 – 38 (*Astronomische Nachrichten*, No. 338; *Mem. Berlin Acad. for* 1838).

The following are the notes made of what was seen here on the evening of October 20th, 1851. The atmosphere being in a state of unusual tranquillity.

Great Refractor, October 20th, 1851, between $10^{h.}$ and $11^{h.}$, P. M.

"*Saturn* looks most beautifully, — steady and distinct. The inner bright ring is minutely subdivided into a large number of small rings, the divisions commencing at the edge next the ball, and extending outwards about two thirds of the breadth." With a power of 800, the dark lines were quite evident, but became fainter towards the outer edge. The appearance was compared to that of a series of waves. The summits corresponding to the narrow rings, and the depressions between to the divisions.

I subjoin Mr. Dawes's notice of the same phenomenon.

October 26th, 1851. The evening up to $11^{h.}\,45$, when it suddenly clouded, was remarkable for distinctness of definition.

"But the most remarkable appearances were observed on the inner bright ring. Its exterior portion to about one fourth of its whole breadth was very bright, being of about the same color as the brilliant zone on the ball immediately north of *Saturn's* equator. Interior to this, the shading off did not appear, as under ordinary circumstances, to become deeper towards the inner edge *without any distinct or sudden gradations of shade.* On the contrary, it was clearly seen to be arranged in a series of *narrow concentric bands*, each of which was somewhat darker than the next exterior one. Four such were distinctly made out. They looked like steps leading down to the black chasm between the ring and the ball. The impression I received was that they were separate rings; but too close together for the divisions to be seen as black lines. The slightest undulation of the images was sufficient to confuse the different shadings, and to destroy the step-like appearance."

NEW WORKS.

The second half of the fourth and last division of the catalogue of stars observed by Professor Rümker with such indefatigable zeal, has just been published by Perthes, Besser, and Mauke, of Hamburg. This catalogue contains the mean places for 1836.0 of more than 12,000 stars observed by Professor Rümker since 1836, with the meridian-circle of the Hamburg Observatory, — together with the eight constant logarithms for each star, to reduce the mean to apparent places. The price of the whole work is 24 Hamburg marks ($9\frac{3}{5}$ Prussian rixthalers), and the several parts or divisions are offered by the publishers at the same rate.

The chief object of Professor Rumker in preparing this catalogue — which, as is well known, has now become a standard work for practical astronomers — was to supply the deficiencies in the *Histoire Céleste* and Bessel's *Zones*, rather than to supersede the catalogues previously existing. The constants a, b, c, d, a', b', c', d', are those of Baily's, not Bessel's, notation. The precession used is that of the *Nautical Almanac*, in the volumes previous to that for 1850.

The present publication not only completes Professor Rümker's laborious and important work, by giving the stars in the last three hours of right-ascension, but contains in the appendix a number of newly-observed stars in the first hour.

G.

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New Works.

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THE
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ON THE ORIGIN OF THE FORMS AND THE PRESENT CONDITION OF SOME OF THE CLUSTERS OF STARS AND SEVERAL OF THE NEBULÆ.

By STEPHEN ALEXANDER,
PROFESSOR OF MATHEMATICS AND ASTRONOMY IN THE COLLEGE OF NEW JERSEY.

(*Continued from page* 111.)

When, however, a catastrophe at length occurred, it seems, indeed, to have taken place in the region most liable to it; viz. that of the equatorial accumulation, and the accumulated tendencies to such a catastrophe seem to have produced a wellnigh simultaneous dispersion of material: for such is the whole appearance of things in *Fig.* 15, which is copied from LORD ROSSE's representation of M. 27, H. 2060 (*Phil. Trans. for* 1844, Plate XIX. Fig. 26). The figure represents the object as it appeared in the three-feet telescope.

Admitting the hypothesis of the spheroidal origin of the nebula, or rather cluster, we may yet trace the primitive form in the figure as here shown, and still more distinctly in *Fig.* 16, which is copied from SIR JOHN HERSCHEL's representation of the same object (*Phil. Trans. for* 1833, Plate X. Fig. 26); in the description of which, the nebula is spoken of as being "shaped like a dumb-bell with the elliptic outline completed by a feeble nebulous light."[*]

In *Fig.* 15 we seem to see the traces of the *divellent* force which drew the superficial portions from the polar regions toward the equator; aided as that force was by the increased centrifugal force due to a more rapid rotation, and its accompanying oblateness. The outline of the central portion, concave toward the equator, is such as the varying direction of the resultant of the contending forces might be supposed to require.

Of the two *Figs.* 15 and 16, the former presents the details more distinctly, as seen in a larger telescope and with a high power; the latter gives a more complete outline of the great features; in accordance with LORD ROSSE's statement in the course of his remarks upon the appearance of this object in the six-feet telescope; — viz. "that while high magnifying power brings out minute stars, it extinguishes faint nebulosity";[†] or — with respect to some portions exhibiting minute stars — also what is stated by SIR JOHN HERSCHEL, speaking of the same object, viz. that "the symmetry of form" is rendered "less striking," by the larger telescope "rendering visible features too faint to be seen with inferior power."[*]

LORD ROSSE, in his description of *Fig.* 15, speaks of the nebula as "a difficult object; it requires an extremely fine night and a tolerably high power; it is then seen to consist of innumerable stars, mixed with nebulosity; and when we turn the eye from the telescope to the Milky Way, the similarity is so striking that it is impossible not to feel a pretty strong conviction that the nebulosity in both proceeds from the same cause"; viz. a blending of the light of very distant stars.[†]

Something like another instance of such a nebula is seen in *Fig.* 19, which is copied from that of SIR JOHN HERSCHEL (*Results of Observations made at the Cape, &c.*, Plate VI. Fig. 1); it represents H. 3514. In the description of it, we find the following remarks: — "It is an oval nebula pretty well defined, though faint, and deviating widely from the normal characters of such nebulæ, so as to approach in some degree to the structure of M. 27 as figured in Fig. 26 of my Northern Catalogue. It is true that the disposition of the bright axis is not nearly so symmetrical, nor are its two terminal masses so conspicuous in proportion to the whole size of the object, — nor indeed is the axis straight. A general similitude however exists to warrant their being provisionally classed together," &c.[‡]

Admitting again the spheroidal origin, it is quite supposable, that no small perturbations may have accompanied the rending of the primitive spheroid, and efforts at new axes of rotation, among others, may have contributed to disturb the symmetry of the resulting cluster.[§]

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[*] *Phil. Trans. for* 1833, p. 465.

[†] *Phil. Trans. for* 1850, p. 507.

[*] *Outlines of Astronomy*, (881).

[†] *Phil. Trans. for* 1844, p. 322.

[‡] *Results of Observations, &c.*, p 24.

[§] In so far as the optical phenomena alone are concerned, we might account for the "dumb-belt" form of the central portion, as well as for the "feeble" "elliptic outline" of the large nebula (*Figs.* 15 and 16), by supposing that we look upon a cluster whose general outline is that of a

At the end of Sir John Herschel's description of this nebula, he says, "For another analogous structure *confer* Dr. Lamont's thesis of August 25, 1837, Fig. IV." *

Another instance of something approaching to the same form is presented by Lord Rosse (*Phil. Trans. for* 1844, p. 323). He says: "*Fig.* 47 is one apparently of another class. It has a star in the center, and is of unequal brightness; the nebulosity is in patches, and I have sometimes fancied, though probably erroneously, that I could discover in it a faint resemblance to Fig. 26"; † which, as already stated, is copied in our *Fig.* 15. The existence of the central star would not be inconsistent with the hypothesis of the spheroidal origin of the nebula.

No other comparatively *simple* nebulæ of this form seem as yet to have been discovered; unless we except H. 3241, represented by Fig. 2 of Plate VI. of *Results of Observations made at the Cape, &c.*, which, however, Sir John Herschel concludes, "may be nothing else than a very close double nebula, whose individuals are small and much compressed." ‡ Of the two *Magellanic Clouds*, the *Nubecula Major*, as seen with the naked eye, shows also a resemblance to the "dumb-bell" form; but of that, more hereafter.

Class III.

(*Primitive, or early derivative, Form, a Ring.*)

The possibility as well as the order of some of the transformations next to be considered, was suggested by the results of the ingeniously devised and instructive experiments of M. Plateau, as detailed in his *Mémoire sur les phénomènes que présente une masse liquide libre et soustraite à l'action de la pesanteur.* §

In the course of his experiments, M. Plateau suspended a mass of olive oil in a mixture of alcohol and water of the same specific gravity with the oil; and having gathered the mass, thus suspended, around an axis, he contrived to give the same a rotatory motion. The oil, at first spherical, soon became spheroidal; and when the rotation was very gradually accelerated, an indentation, after a while, appeared at each pole, the depth of which increased continually, until the whole was transformed into a ring, with sometimes a central film marking the plane of the equator of the spheroid, and still attaching the ring to the axis.

M. Plateau, in his comments upon a subsequent memoir of his own upon the same subject, distinctly states, that he regards the resemblance between the results of his experiments and certain "astronomical facts" as being merely incidental.*

Yet a like arrangement of forces, themselves not wholly dissimilar to those which prevailed in this small mass, might, as it would seem, have subsisted in some examples of the enormous and highly oblate spheroids already supposed in the description introductory to Class I.

For when the cohesion was so considerable that the catastrophe (i. e. the rupture of the spheroid) was *long deferred*, then the contraction due to a rapid and long continued cooling of the surface, and even of *portions somewhat below the surface*, together with the sensibly increased cohesion, might all combine to furnish a *contractile force* analogous to the *molecular* action at the surface of the small mass, — analogous on a scale truly immense, yet not disproportionate to the incomparable greatness of the primitive spheroid,† — and this action would be but slightly disturbed by a feeble *central* gravitation.

Now the analogy thus traced, and which is accepted as suggestive, may not be sufficiently perfect to justify a conclusion as to what must actually have occurred in the case of the great primitive spheroid here contemplated. Yet it will not be out of place to observe, that such a contractile force, if brought into action, must, most probably, have been efficient in directions tending on all sides *toward* the equatorial ring, where (see 1st and 6th effects, pp. 98 and 99) the cooling and contraction (and therefore also the contractile force) must be presumed to have been most efficient. Besides, in the very instance of a highly oblate spheroid, in which the catastrophe was *long deferred*, the destructive powers (p. 99) would *therefore* be very largely accumulated in the region of the equatorial ring already described. Moreover, the contractile force now in question would be *superadded* to the increased and increasing divellent force (described, p. 99); for, as already stated, this contractile force would most probably produce a tendency on all sides *toward* the equatorial ring.

The greater portion of the spheroid might thus, it would seem, be accumulated in the equatorial ring itself; the portions near the surface having been extensively drawn toward that region of the spheroid, as also the interior portions adjacent to the ring: insomuch that the ring so increased, instead of an incidental appendage, would become the most distinct feature

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prolate spheroid, with a more condensed arrangement of a part of it, in the form of an equatorial ring of stars. This last would appear both more dense and broader at the edges of our field of view; where it would be decidedly more foreshortened. The whole of this would besides be remarkably consistent with what we see in *Fig.* 19; even the curvature of the "bright axis" being a fact in place; — our view being oblique.

But although the *optical phenomena* would thus be accounted for, it would not be easy to determine the conditions which would render such an arrangement *mechanically supposable*; whether we have regard to the primitive form of the mass, from which we may presume originated what we now see, or suppose, if possible, that a *dynamical* equilibrium is still *somehow* maintained.

* I have not access to Dr. Lamont's thesis, and Lord Rosse does not mention the locality of the nebula represented by his *Fig.* 47, which is next noticed; I cannot therefore determine whether it is the same with Dr. Lamont's, or whether it must be regarded as another instance of this peculiar form. I have presumed the latter to be the fact.

† *Phil. Trans. for* 1844, p. 323.

‡ *Results of Observations, &c.*, p. 24.

§ *Mémoires de l'Académie de Bruxelles*, Tome XVI.

* He speaks of the astronomical developments with which he had formerly compared his results as "faits astronomiques, faits que ne peuvent avoir que des rapports fortuits avec les resultats des mes expériences." (*Annales de Chimie et de Physique*, 3e. Série, Tome XXX p. (204), note.)

† For an estimate of the very great contractile force due to mere molecular action, in the instance of a fluid not much more dense than water, see the results of Professor Henry's experiments, as stated in the *Proceedings of the American Philosophical Society*, Vol. IV. p. 85.

in the form of the mass. The whole of the rotating mass might then be described as a ring with a thin interior plate, still indicating the plane of the equator of the primitive spheroid;* a form *like that obtained experimentally by* M. PLATEAU, but on a scale too great to be adequately estimated.

We might even neglect or disallow the action of the contractile force, and, with a sufficient cohesion and a long deferred catastrophe, we should find that the action of the other forces must bring about an approximation to a like form of the mass. In either case, the result must be an *inferior density* of the portions interior to the ring, except, it may be, at the center: whatever else may be regarded as uncertain.

Should these conclusions be regarded as admissible, then the form of a ring adhering to the central portion would be the *early derivative* form of the mass, — as is expressed in the title to this Class.

But, aside from all this, a ring without a central mass, and rotating in a state of *dynamical* equilibrium, is itself mechanically supposable; † and we are therefore at liberty to regard the annular form as an ultimate fact: and it thus would be, *for us*, the *primitive* form, — the other alternative indicated in the title to the Class.

The rupture and partial dispersion of masses very much like these, seem together to have furnished two descriptions or orders of clusters and nebulæ.

Order 1st. Annular Nebulæ and Clusters.

Cohesion and the other conservative forces, though long efficient in the equatorial ring, seem at length to have yielded to the accumulation of opposing tendencies already specified. Curved branches, as it would appear, were at first thrown off, as in the cases of the spirals and globular clusters already noticed; and then the separation of the remaining portion would seem to have been wellnigh simultaneous.

Accordingly, in *Fig.* 29 we see the curved appendages bordering the broken ring; which itself appears elliptical because it is seen somewhat obliquely: and, if we assume the previous existence of such a less dense interior portion as has been already described, we may still discern its rent and broken remnants, — rent and broken by their adhesion to the dense portions exterior to them.

This figure is a copy of that of LORD ROSSE (*Phil. Trans. for* 1844, Plate XIX. Fig. 29). It represents the annular nebula in *Lyra*, M. 57, H. 2023, as seen in the three-feet telescope. LORD ROSSE says of it: —

"The filaments proceeding from the edge become more conspicuous under increasing magnifying power, within certain limits, which is strikingly characteristic of a cluster; still, I do not feel confident that it is resolvable. I am, however, disposed to think that it was never examined when the instrument was in as good order, and the night as favorable, as on the occasions when the resolvable character of Fig. 26" (our *Fig.* 15) "was ascertained." * As seen with the six-feet instrument, "the central opening has considerably more nebulosity," "and there is one pretty bright star in it *s. f.* the center." †

H. 2072 (IV. 13 of SIR WILLIAM HERSCHEL) is represented in the *Philosophical Transactions for* 1833, Plate XIII. Fig. 48; also H. 3680 and 3686 are represented in the *Results of Observations at the Cape*, *&c.*, Plate VI. Figs. 3 and 4 respectively; all as seen with SIR JOHN HERSCHEL's reflector of 18¼ inches aperture, and 20 feet focus. They resemble not a little the annular nebula in *Lyra* as seen with the same instrument, though all, it would seem, of an inferior intensity; and the apparent form of 3686 is more nearly circular than that of any of the others. 2072 was more completely resolved by LORD ROSSE. †

H. 218 (or V. 19 of SIR WILLIAM HERSCHEL) is represented in the *Philosophical Transactions for* 1833, Plate X. Fig. 28. It is described by SIR JOHN HERSCHEL as being "of the last degree of faintness, and may very well be unperceived, though full in the field of view. There can hardly be any doubt of its being a thin flat ring, of enormous dimensions, seen very obliquely" ‡ It would seem to be proportionately much narrower and more open than the nebula in *Lyra*.

H. 1981 (IV. 11 of SIR WILLIAM HERSCHEL) is classed by SIR JOHN HERSCHEL among the annular nebulæ (*Outlines of Astronomy*, note to (875)); though also marked as being "planetary?" in the description in his Northern Catalogue.

Fig. 30 is a representation of H. 1909. It is copied from LORD ROSSE's figure (*Phil. Trans. for* 1850, Plate XXXVII. Fig. 8). It is described as being "a very bright resolvable nebula, but none of the component stars to be seen distinctly even with a power of a thousand. A perfectly straight and longitudinal division in the direction of the major axis. Resolvability most strongly indicated towards the nucleus." §

"The dark chink might indicate either a real opening, the system being an elliptic ring, or merely a line of comparative darkness, the section through the axis of a very long, narrow elliptic shell." ||

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* The thickness in the case of the *very* oblate spheroid here supposed would be small even at the outset, and reduced on both sides, by the action of the forces here specified.

† Such in effect was the statement of Professor PEIRCE to the American Association for the Advancement of Science, at their Fifth Meeting at Albany, in August, 1851; as being a result obtained in the course of his analytical investigations relative to the rings of *Saturn*.

* *Phil. Trans. for* 1844, pp. 322, 323.

† *Phil. Trans. for* 1850, p. 506.

‡ *Phil. Trans. for* 1833, p. 498.

§ *Phil. Trans. for* 1850, p. 512.

|| *Ibid.*, p. 508.

(*To be continued.*)

OBSERVATIONS OF ENCKE'S COMET, AND OF PARTHENOPE,

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By Mr. JAMES FERGUSON.

[Communicated by Lieutenant Maury.]

[Corrected for refraction.]

ENCKE'S COMET.

Date.	M T Washington.	No. of Comp	Comparison-Star.	☄ − *		☄'s apparent		A.
				Δα	Δδ	α	δ	
1852.	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″	
Jan. 12	6 47 3.0	4	Weisse XXIII. 48	+1 45.82	− 7 5.69	23 5 26.94	+4 4 53.38	7
		4	" 111	−1 0.30	− 6 35.59	5 27.33	4 4 52.90	7
11	6 41 7.9	6	" 111	+1 19.87	+ 3 24.29	7 47.46	4 14 52.51	5
19	6 48 14.5	4	B. A. C. 8127	+1 21.50	+10 50.80	14 8.51	4 45 11.92	7
22	6 55 19.5	6	Weisse XXIII. 359	+0 24.44	− 8 42.78	18 12.95	5 4 50.48	7
23	6 43 33.7	5	Santini 1633	−1 6.78	− 3 36.39	19 35.79	5 11 55.88	7
24	6 41 39.5	8	"	+0 19.86	+ 3 24.62	21 2.51	5 18 57.71	8
25	6 54 44.6	8	Santini 1635	+0 32.05	+ 9 6.69	22 30.69	5 26 18.12	8
26	7 2 14.9	3	Weisse XXIII. 458	+1 11.74	− 2 42.63	24 0.59	5 33 48.57	8
27	6 42 2.2	6	"	+2 39.62	+ 4 47.28	25 28.47	5 41 18.41	9
Feb. 2	6 53 13.4	14	Santini 1649	+0 36.14	+ 3 7.55	34 58.95	6 28 50.96	8
3	6 55 22.2	10	"	+2 15.48	+11 24.12	36 38.27	6 37 7.42	8
7	7 21 41.9	10	*a*	+0 39.56	− 6 7.71	43 33.03	7 11 22.67	7
8	6 46 26.8	7	B. A. C. 8272	+4 39.56	− 5 43.83	45 16.69	7 19 35.53	8
9	6 58 45.1	13	Santini 1664	−0 56.09	+ 4 40.69	47 6.06	7 28 35.50	8
12	6 41 14.0	3	B. A. C. 8353	+2 12.68	−13 55.79	52 35.45	7 53 53.47	6
11	6 51 59.6	12	"	+1 33.05	+ 2 45.64	23 56 21.17	8 10 31.75	8
17	7 3 42.1	8	Santini 8	−2 4.34	+15 31.10	0 2 6.22	8 34 21.61	9
29	6 54 58.1	7	Santini 31 B. A. C. 137	−2 32.07	−11 42.09	23 57.20	9 17 30.05	9
Mar. 1	6 59 34.1	8	"	−1 7.88	−16 51.80	25 21.37	9 12 20.22	10
3	6 54 41.2	9	Weisse O. 436	+1 50.52	− 2 55.68	27 38.50	8 54 6.65	8
6	6 52 55.4	10	" 491	+0 30.83	− 3 38.84	29 14.68	7 59 43.29	9
	7 23 43.7	4	" 491	+0 30.66	− 4 9.80	29 14.52	7 59 12.21	9
7	6 42 13.3	3	" 476	+1 15.55	+12 29.56	29 5.75	7 32 12.70	10
	7 3 35.9	8	" 476	+1 14.88	+12 6.24	29 5.09	7 31 49.38	10
10	6 59 7.6	5	" 450	−0 43.35	+23 2.67	0 25 45.95	+5 31 13.30	10

From the 12th to the 25th of January, the comet was seen with difficulty, bearing scarce any illumination. It was faintest on the 12th, 23d, and 24th. On the 25th it covered a small star of the 11th magnitude, which was at first taken for its nucleus. The observations of the 25th are better than any preceding. From the 25th of January to the 8th of February the comet increased in distinctness, presenting a condensation of light resembling a cluster of stars of the 12th magnitude of about two minutes in diameter, surrounded by a coma having three elongations, the central one being the largest about three minutes of arc, and its angle of position 70°. On the 14th of February, the condensation more bright, with two rays, the angle of position of one about 300°, and the other 90°. The light not nebulous, and pearly, as at first, but fibrous. The diameter of the central part two minutes of arc. On the 3d of March, the first two comparisons were made without illuminating the wires. The comet then had a crescent appearance, — the concave side next the sun; the condensation being nearest the southern point of the crescent, and about the same diameter as before. In the observations of the 6th, 7th, and 10th of March, the first comparisons were made without illumination. On the 6th, nothing peculiar was observed; but on the 7th the comet presented a condensation of nearly the same diameter and appearance as before, with a thin beam of light about 30″ in diameter, and eleven minutes of arc in length. It was measured with the micrometer, its angle of position being 325° 55; this being nearly the direction of the elongations previously mentioned. On the 10th, this appearance was not visible.

Adopted Mean Places for 1850.0, *of Comparison-Stars.*

*	Mag.	α	δ	Authority.	No. of Comp.
		h. m. s.	° ′ ″		
Weisse XXIII. 48	7.8	23 3 36.65	+4 16 26.75	Santini's Catalogue, Mem. Astr. Soc.	
" 111	7.8	6 23.12	4 10 56.01	Weisse's Catalogue.	
B. A. C. 8127	6	12 42.12	4 33 49.11	Rümker, Astr. Nachr. 795.	
Weisse XXIII. 359	9	17 44.02	5 13 1.51	Weisse's Catalogue.	
Santini 1633	8.9	20 38.08	5 15 1.14	Rümker, Astr. Nachr. 795.	
" 1635	8.9	21 54.16	5 16 39.54	" " "	
Weisse XXIII. 458	8.9	22 44.37	5 35 59.30	" " "	
Santini 1649	6.7	34 18.31	6 25 11.67	Santini's Catalogue.	
B. A. C. 8272	7	40 32.69	7 24 47.84	Rümker, Astr. Nachr. 795.	
a	9.10	42 48.67	7 16 58.38	Washington Equatorial, from preceding.	9
Santini 1664	7	47 57.63	7 23 23.30	Rümker, Astr. Nachr. 795.	
B. A. C. 8353	7	23 54 13.61	8 7 17.79	" " "	
Santini 8	7	0 4 6.02	8 18 19.35	Santini's Catalogue.	
B. A. C. 137	7	26 24.68	9 28 41.72	Rümker, Astr. Nachr. 795.	
Weisse O. 436	9	25 43.40	8 56 32.19	Weisse's Catalogue.	
" 491	8	28 39.28	8 2 52.15	"	
" 476	9	27 45.24	7 19 13.39	"	
" 450	8	0 26 24.76	+5 7 41.23	"	

PARTHENOPE.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	⑪ — *		⑪'s apparent		A.
				$\Delta\alpha$	$\Delta\delta$	α	δ	
1851.	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″	
Aug. 6	13 9 7.6	1	Weisse II. 81	+0 27.43	+10 28.82	2 6 46.87	+7 30 52.91	10
13	12 53 34.1	8	" 158	+1 15.12	+ 9 7.22	12 5.36	38 38.51	10
16	12 26 5.9	5	" 235	—1 3.80	—12 10.12	13 59.92	39 45.57	10
	12 50 50.1	8	" 235	—1 2.92	—12 9.25	14 0.80	7 39 46.44	10
Oct. 6	11 41 31.9	3	" 112	+0 36.28	— 9 42.56	8 38.87	4 47 48.06	8
8	11 24 10.7	6	" 112	—0 59.86	—21 23.20	7 2.76	36 7.44	9
9	10 39 20.7	4	B. A. C. 687	+0 29.77	+11 21.77	6 13.99	30 26.68	10
	11 18 10.2	4	"	+0 28.20	+11 15.07	6 12.27	30 16.98	10
10	10 50 41.4	14	"	—0 21.18	+ 5 31.11	5 22.39	4 24 33.03	9
15	10 33 33.2	4	"	—2 49.87	— 8 21.64	2 1 1.17	3 55 40.73	10
17	10 30 26.9	6	Weisse II. 7	—2 45.60	+12 41.43	1 59 11.34	44 25.03	10
23	10 23 44.2	8	" I. 963	—0 19.86	— 7 42.80	53 38.51	3 12 18.62	8
31	10 19 5.4	10	" I. 847	—0 43.23	— 3 40.52	46 24.42	2 36 7.77	9
Nov. 1	9 21 55.3	10	B. A. C. 574	—0 19.07	+ 5 12.85	45 34.46	32 26.27	10
7	10 19 13.8	4	"	—5 12.09	—14 35.02	40 41.34	12 37.88	10
11	10 20 49.8	6	Weisse I. 675	+1 7.76	+11 10.64	37 49.90	2 3 21.59	8
22	9 35 37.6	1	Santini 91	+1 12.30	+ 4 2.00	31 53.83	1 53 46.42	10
(1) 26	10 15 21.7	5	"	—0 10.02	+ 6 30.92	30 31.35	1 56 15.48	7
(1) Dec. 1	8 15 12.3	6	"	—1 13.58	+13 55.55	29 27.89	2 3 40.28	8
14	7 41 10.1	3	Weisse I. 562	—2 8.98	+ 1 33.25	29 55.46	43 37.55	9
17	7 25 2.7	4	" 562	—1 24.34	+14 27.14	30 40.07	2 56 31.23	4
18	7 17 19.1	3	" 562	—1 6.31	+19 4.60	30 58.10	3 1 8.64	8
	7 37 8.5	5	" 497	+2 11.43	— 0 26.85	30 58.04	1 9.79	8
23	8 39 41.2	4	" 540	+1 34.65	+ 4 23.29	32 51.42	26 25.33	7
26	8 32 42.2	3	" 607	+0 37.25	— 1 39.42	34 16.31	42 51.49	7
		3	" 628	—0 14.61	+ 2 9.61	34 16.31	3 42 55.75	7
1852								
Jan. 24	7 24 25.2	6	B A. C. 641	+0 12.58	+ 2 32.74	1 57 14.79	7 3 53.62	8
27	7 56 56.2	5	Weisse I. 1040	+2 4.70	— 4 27.75	2 0 27.63	27 43.19	9
30	9 47 34.3	4	B. A. C. 672	+0 19.86	+ 0 1.67	3 31.79	7 52 21.42	7
Feb. 8	8 2 4.6	6	" 741	—2 10.88	+ 2 49.77	14 24.11	9 5 12.41	8
14	8 3 11.29	4	Weisse II. 305	+3 13.29	+ 1 12.86	2 22 1.94	+9 54 54.24	8

The observations to the 16th of August have been published in the *Astronomical Journal* and the *Astronomische Nachrichten*.

(1) The observations of November 26 and December 1 are doubtful.

Adopted Mean Places, 1850.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
		h. m. s.	° ′ ″	
Weisse II. 81	9	2 6 15.06	+7 20 0.58	Weisse's Catalogue.
" 158	7	10 45.67	7 29 7.25	" "
" 235	8	14 59.08	7 51 31.59	" "
" 112	9	7 56.89	4 57 0.42	" "
B. A. C. 687	7	5 38.45	4 18 31.4	British Association Catalogue.
Weisse II. 35	9	3 45.24	4 3 31.69	Weisse's Catalogue.
" II. 7	8	2 1 51.15	3 31 12.70	" "
" I. 963	9	1 53 52.56	3 19 30.07	" "
" I. 847	8	47 1.78	2 39 16.96	" "
B. A. C. 574	4.5	45 47.55	2 26 41.6	α from Gr. 12 Y. Cat.; δ from B. A. C.
Weisse I. 675	8.9	36 36.30	1 51 39.58	Weisse's Catalogue.
Santini 91	7.8	30 35.72	1 49 12.67	Santini's Catalogue.
Weisse I. 562	8.9	31 58.75	2 41 33.91	Weisse's Catalogue.
" 497	8.9	28 40.96	3 1 6.16	" "
" 540	9	31 11.15	3 21 31.98	" "
" 607	9	33 33.35	3 44 1.06	" "
" 628	9.10	31 25.30	3 40 16.41	" "
B. A. C. 641	7	56 56.72	7 0 53.6	British Association Catalogue.
(1) Weisse I. 1040	7	1 58 17.46	7 31 43.44	Santini's Catalogue.
B. A. C. 672	6	2 3 26.47	7 51 53.08	" "
" 741	7	16 29.93	9 1 57.25	" "
Weisse II. 305	8	2 18 43.24	+9 53 16.15	Weisse's Catalogue.

(1) This star is erroneously marked in WEISSE as of the 9th magnitude. BESSEL in the Zones and SANTINI both put it at 7.

FROM A LETTER OF LIEUTENANT GILLISS TO MR. WALKER.

U. S. Astronomical Expedition, Santiago de Chile, 1852, January 20.

THE volume of Observations of *Venus* went to the Navy Department at the termination of the series, in the hope that there would be found some corresponding ones either by the Washington or Cambridge Observatory. Those obtained in the morning twilight were generally very satisfactory; — and in our calm summer mornings there is a sharpness and steadiness in the apparent motion of celestial objects, admitting almost any degree of accuracy in their measurement. The next series will be during our winter months, and, as the planet will then be very far to the northward, it may very well be doubted whether we shall be repaid for remaining in Chili to observe *Venus* only.

I am getting on famously with the final series on *Mars*, having had only four cloudy nights in December, and two so far this month. Besides these, there were no *differential* measures Christmas night, with the star in the ephemeris, there having been an error in its reduction, — nor any January 15, for the same reason. If your observers have had observations on even half the nights, and their work has been as satisfactory as mine has on many occasions, we may reasonably expect a gratifying result. Your ephemeris of *Neptune* seems so perfect, that it seems useless to send you further observations; but I subjoin the view which our zone-work would allow us to make. BESSEL's refractions have been used in their reduction, and no correction has been applied for parallax. Our meridian is assumed approximately as $4^{h.}\ 42^{m.}\ 18^{s.}.9$ west of that of Greenwich, and our latitude as 32° 26′ 24″.8 S.; but it is not improbable our observations will show that they must have special refraction tables.*

1851.	♆ α	♆ δ
	h. m. s.	° ′ ″
Sept. 9	22 38 28.55	—9 31 28.5
11	38 16.46	32 26.8
12	38 10.63	32 57.6
15	37 52.59	31 48.8
Oct. 5	36 4.07	45 26.8
17	35 13.03	50 20.6
Nov. 1	22 34 29.25	—9 54 28.6

Our zone-work makes steady progress, though we shall not sweep more than half the space I had hoped; but leave a belt some 25° wide between our highest zone and the zenith, to be observed by other astronomers. We shall, however, have obtained very little if any thing short of 30,000 stars in the 25° surrounding the pole. First, the unfortunate accident to our micrometer, then the extraordinary number of cloudy nights during the last year, and finally want of sufficient force, have all combined to bring about this result. . . . .

---

* As Lieutenant GILLISS does not give the times of the observations, they were probably made in the meridian. G.

On the 5th instant, I had an opportunity to observe two occultations of η *Geminorum* by the moon, the star reappearing in a valley between two high mountains on the southern limb, across which it was apparently $36^{s}.9$ in traveling. As I have no recollection of a similar observation, and it will give you a very accurate position of the moon, the times of the phenomena are transcribed.

	h.	m.	s.	
1st Imm.	6	41	54.7	Sid. time Santiago.
1st Em.	6	41	31.1	
2d Imm.	6	45	8.0	
2d Em.	6	46	0.5	

You will recollect that we are 2,000 feet above the ocean, which will sensibly influence the moon's parallax at the time.

J. M. GILLISS.

FROM LETTERS OF DR. PETERSEN TO THE EDITOR.

Altona, 1852, *April* 16.

SINCE my last letter I have received the following observations of the last new planet of GASPARIS.

Observations in Naples by Professor DE GASPARIS.

1852.	M. T. Naples. h. m. s.	⑯ App. α h m. s.	⑯ App δ ° ′ ″	No. Comp.	
March 22	7 58 37.3	9 55 25.1	+13 8 16	6	
24	7 59 20.1	9 54 32.4	13 14 4	5	
27	8 12 11.2	9 53 20.6	13 22 14	5	Doubtful.
29	8 40 3.6	9 52 38.2	13 27 3	6	
30	9 8 45.8	9 52 18.5	+13 29 6	3	

Mr. GASPARIS remarks concerning these observations, that it was with great difficulty that he succeeded in following the planet, partly by reason of its feebleness, and partly on account of the moonlight and unfavorable weather, — and that for this reason the observations are less reliable.

Observations in London by Mr. HIND.

1852.	M. T. Greenwich. h. m. s.	⑯ α h. m. s.	⑯ N. P. D. ° ′ ″
April 3	11 43 58	9 51 14.03	76 22 30.5
4	8 38 18	9 51 3.94	76 21 20.6

Mr. HIND considers these observations as good under the circumstances, and estimates the planet's magnitude as below the 11th.

The barometer has stood here very high throughout March up to the very last, but I have never seen it so high as it was March 4, 5, and 6. The height was so remarkable that I send you some of the observations on those days. They are all of them absolute determinations, reduced to 0° R., and the position of the barometer is 78 Paris feet above the level of the sea.

1852.	M. T. Altona. h.	m.	True Height of the Mercury. in.	l.
Mar. 4	23	50	28	10.35
5	0	20		10.33
	1	20		10.38
	2	20		10.47
	3	50		10.47
	5	0		10.68
	6	0		10.70
	7	0		11.00
	7	30		11.02
5	8	30	28	11.03
Mar. 5	9	0	28	10.95
	9	30		10.87
	10	0		10.92
	11	30		11.14
	12	0		11.22
	12	30		11.30
	13	0		11.37
	13	30		11.50
	14	0		11.41
5	14	30	28	11.35
Mar. 5	15	0	28	11.15
	19	48		11.50
5	22	35		11.46
6	0	0		11.50
	0	30		11.34
	1	0		11.31
	1	30		11.18
	2	0		11.05
	2	30		10.96
	3	0		10.98
	3	30		10.96
	4	0		10.85
6	4	30		10.90
Mar. 6	5	0	28	10.86
	5	30		10.72
	6	0		10.62
	6	35		10.58
	7	10		10.69
	7	40		10.60
	9	25		10.57
	10	45		10.33
	13	0		10.02
	18	50		9.17
6	23	30		8.62
7	0	20	28	8.39

Although only small changes took place during these 48 hours, a maximum appears to have occurred in the morning hours of March 6. It would be very interesting to know how the barometer stood in America at that time.

I have just received the following elements of the newest planet from Mr. G. RÜMKER in Hamburg. They are computed from the Naples observations of March 19 and 29, and the London observation of April 4, — and represent these observations precisely.

April 1.0, 1852, Mean Berlin Time.

$$\begin{aligned} M &= 280^\circ\ 25'\ 21''.5 \\ \pi &= 253\ \ 56\ \ 20.8 \\ \Omega &= 150\ \ 14\ \ 11.7 \\ i &= 2\ \ 43\ \ 8.1 \\ \phi &= 7\ \ 42\ \ 56.3 \\ \text{Log. } a &= 0.1965374 \\ \text{Log. } \mu &= 2.8052005 \end{aligned}$$

(π and Ω:) Mean Equinox, Jan. 0.0, 1852.

1852, *April* 20.

G. Rümker has computed an ephemeris of the newest planet from his elements, for 9h. 36m. M. T. Berlin. Although I much fear that it will have expired before it reaches you, I send it.*

	⑯ α h. m. s.	⑯ δ	
May 1	9 53 42	+13 37.3	
2	54 4	35.6	0.42823
3	54 28	33.9	
4	54 53	32.0	
5	55 19	30.0	
6	55 47	27.9	0.43609
7	56 16	25.7	
8	56 46	23.4	
9	57 17	21.0	
10	9 57 48	+13 18.6	0.44391

E. Vogel, now in London, has computed from the observations in Naples, March 19, and Regent's Park, April 3 and 12, the following very different elements: —

1852, April 0.0, Berlin.

M	77° 38′ 43″.33	
π	33 36 43.23	Mean Equinox, 1852.0
☊	151 11 36.52	
i	3 30 14.67	
ϕ	24 39 56.22	
Log. μ	2.820152	
Log. a	0.486570	

The middle observation is represented by these elements, according to Mr. Vogel, within 0″.1 in longitude, and precisely in latitude.

The following are observations of the new planet made by Professor Argelander in Bonn.

1852.	M. T. Bonn. h. m. s.	⑯ α	⑯ δ	No. Comp.	*
April 9	12 11 43.7	147° 34′ 58″.2	+13° 45′ 3″.0	2	*c*
12	8 22 20.4	32 24.4	47 13.1	6	*c*
	12 13 51.4	32 20.9	47 20.6	6	*c*
	12 29 16.8	32 17.2	47 21.0	6	*d*
	12 45 2.8	32 15.4	47 22.7	6	*d*
13	9 0 11.0	32 6.3	47 47.4	6	*c*
	9 16 5.8	32 6.5	47 48.1	6	*d*
14	9 8 13.0	32 6.5	48 17.2	6	*d*
	9 23 31.3	147 32 9.3	+13 48 15.8	6	*c*

The assumed places of the comparison-stars are, —

c	147° 37′ 39″.8	+13° 56′ 40″.7
d	147 35 59.8	+13 30 56.0

The following are by Professor Rümker in Hamburg: —

1852.	M. T. Hamburg. h. m. s.	⑯ α	⑯ δ	No. Comp.
April 11	9 58 14.6	147° 32′ 57″.6	+13° 46′ 47″.6	6
14	9 2 —	147 32 5.2	+13 48 19.6	2
April 15	8 47 —	147° 32′ 26″.6	+13° 48′ 37″.5	1
16	8 46 31.2	147 32 52.5	+13 49 1.2	6

The place of the comparison-star was determined by two observations with the meridian-circle: —

h. m. s. 9 49 11.35 +13° 51′ 29″.9

A. C. PETERSEN.

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* The ephemeris for April 1 omit, as not being needed by our observers. — G.

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From a Letter of Lieutenant Gilliss to Mr. Walker.

From Letters of Dr. Petersen to the Editor.

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ON A UNIVERSAL FORMULA FOR THE SUMMATION OF SERIES.

By L. W. MEECH, A. M.

Recent investigations have suggested the inquiry whether the series ordinarily treated by the differential method, or by the artifices of Demoivre, and of the Bernoullis, may not all be summed by one uniform process? There is a formula, first given by Euler, which from some informality of demonstration seems to have been misapprehended, and which will go far to give to this inquiry an affirmative answer. The elegance and efficiency of this formula render it extremely valuable for the numerous researches involving the summation of series; while its simplicity of adaptation entitles it to a place in our common treatises on the calculus. Let it first be proposed to obtain a new demonstration, that shall be obvious and perfectly general.

The general term or xth term of the series being ordinarily known, let it be here denoted by $F(x) = u$, where u is a function of x. Attributing to x the successive values, $1, 2, 3, 4, \ldots\, x$, and denoting the sum of the resulting series by Σu, it remains to be shown that

$$\Sigma u = \int u\,dx + \tfrac{1}{2}u + \frac{1}{2\,.\,6}\frac{du}{dx} - \frac{1}{2^3\,.\,90}\frac{d^3u}{dx^3} + \frac{1}{2^5\,.\,945}\frac{d^5u}{dx^5} - \ldots + C.$$

Which is a theorem somewhat similar to Taylor's, upon which it is founded, but far more convergent.

Imagine the several terms of the original series to be ordinates of a curve, and erected at a unit's distance from each other, along an "axis of X"; then, by the well-known formula of the calculus, $\int u\,dx$ will represent the area of this curve.

Again, connecting the upper adjacent extremities of the ordinates by straight lines, there will be represented an inscribed semi-polygon made up of parallel trapezoids whose bases are each equal to unity, and their areas equal to $\frac{1}{2}(0 + F_{(1)}) + \frac{1}{2}(F_{(1)} + F_{(2)}) + \ldots\, \frac{1}{2}(F_{(x-1)} + F_{(x)})$; adding the contiguous half terms, it becomes $\Sigma F_{(x)} - \frac{1}{2}F_{(x)}$, or $\Sigma u - \frac{1}{2}u$.

Between each trapezoid and the curved line above it is a small segment; and if $f(x)$ or u' denote the area of the last or xth segment, then $\Sigma f(x)$ or $\Sigma u'$ will denote their collective area. The whole curve being made up of the inscribed semi-polygon and these segments, we have

$$\int u\,dx = \Sigma u - \tfrac{1}{2}u + \Sigma u',$$

or

$$\Sigma u = \int u\,dx + \tfrac{1}{2}u - \Sigma u'.$$

With respect to the last term, suppose u' to be referred to a new curve, as has already been done for u, and so on; then,

$$\Sigma u' = \int u'\,dx + \tfrac{1}{2}u' - \Sigma u'',$$

$$\Sigma u'' = \int u''\,dx + \tfrac{1}{2}u'' - \Sigma u''' \ldots.$$

Subtracting the last of these three equations from the preceding, and that result from the first, and canceling,

$$\Sigma u = \left.\begin{aligned} &\int u\,dx + \tfrac{1}{2}u - \int u'\,dx - \tfrac{1}{2}u' \\ &\qquad + \int u''\,dx + \tfrac{1}{2}u'' \\ &\qquad - \;\ldots\; - \ldots \end{aligned}\right\}$$

It is now necessary to determine u' in terms of u, or of x. Recurring to the last segment of the curve above referred to, it is evident that its area above the trapezoid, and denoted by u', is equal to

$$u' = \int F_{(x)}\,dx - \int F_{(x-1)}\,dx - \tfrac{1}{2}(F_{(x)} + F_{(x-1)}).$$

Developing by Taylor's theorem; since $u = F_{(x)}$,

$$F_{(x-1)} = F_{(x)} - \frac{du}{dx} + \frac{d^2u}{1.2\,dx^2} - \frac{d^3u}{1.2.3\,dx^3} + \ldots$$

$$\int F_{(x-1)}\,dx = \int F_{(x)}\,dx - u + \frac{du}{1.2\,dx} - \frac{d^2u}{1.2.3\,dx^2} + \ldots$$

Substituting the two right-hand values in the former equation, the first terms will cancel each other, leaving

$$u' = -\tfrac{1}{12}\frac{d^2u}{dx^2} + \tfrac{1}{24}\frac{d^3u}{dx^3} - \tfrac{1}{80}\frac{d^4u}{dx^4}. + \ldots$$

That is, each derived function is equal to $-\frac{1}{12}$th of the second differential coefficient of the preceding, $+\frac{1}{24}$th of the third, &c.

$$u'' = \tfrac{1}{144}\frac{d^4u}{dx^4} - \ldots$$

whence,

$$-\tfrac{1}{2}u' + \tfrac{1}{2}u'' - \ldots\ldots = \tfrac{1}{24}\frac{d^2u}{dx^2} - \tfrac{1}{48}\frac{d^3u}{dx^3} + \tfrac{7}{720}\frac{d^4u}{dx^4} - \ldots\ldots$$

$$-\int u'\,dx + \int u''\,dx - \ldots\ldots = \tfrac{1}{12}\frac{du}{dx} - \tfrac{1}{24}\frac{d^2u}{dx^2} + \tfrac{7}{360}\frac{d^3u}{dx^3} - \ldots\ldots$$

Substituting these last two values in the equation above,

$$\Sigma u = \int u\,dx + \tfrac{1}{2}u + \tfrac{1}{12}\frac{du}{dx} - \tfrac{1}{720}\frac{d^3u}{dx^3}\ldots\ldots + C,$$

as was to be demonstrated. Let it now be applied to different examples of series, whose xth term is a function of x.

I. To find the sum of the *arithmetical progression*,

$$d + 2d + 3d + \ldots + xd = \Sigma u.$$

Here $u = xd$; $\int u\,dx = \tfrac{1}{2}x^2 d$; $\frac{du}{dx} = d$.

Whence $\Sigma u = \tfrac{1}{2}x^2 d + \tfrac{1}{2}xd + \tfrac{1}{12}d + C$.

If $x = 1$, $d = \tfrac{1}{2}d + \tfrac{1}{2}d + \tfrac{1}{12}d + C$.

Subtracting, $\Sigma u = \tfrac{1}{2}x(xd + d)$. Which result coincides with the common arithmetical rule.

II. To find the sum of the *geometrical progression*,

$$ar + ar^2 + ar^3 + \ldots\ldots + ar^x.$$

Here $u = ar^x$; $\int u\,dx = \frac{ar^x}{\log r}$.

$$\frac{du}{dx} = ar^x \log r;\ \frac{d^3u}{dx^3} = ar^x \log^3 r;\ \text{\&c.}$$

The sum of the coefficients of ar^x being constant, denote it by B; then will

$$\Sigma u = Bar^x + C.$$

If $x = 1$, $ar = Bar + C$.

If $x = 0$, $0 = Ba + C$.

Whence $\Sigma u = \frac{ar^{x+1} - ar}{r - 1}$; which also agrees with the well-known rule.

III. To find the sum of the natural *series of Squares*,

$$1^2 + 2^2 + 3^2 + 4^2 + \ldots\ldots + x^2.$$

Here $u = x^2$; $\int u\,dx = \frac{x^3}{3}$.

$$\frac{du}{dx} = 2x;\ \frac{d^3u}{dx^3} = 0.$$

$$\Sigma u = \frac{x^3}{3} + \tfrac{1}{2}x^2 + \tfrac{1}{6}x = \tfrac{1}{6}x(x+1)(2x+1).$$

Where the correction is zero.

IV. To find the sum of the *reciprocal series*,

$$1 + \tfrac{1}{2} + \tfrac{1}{3} + \tfrac{1}{4} + \tfrac{1}{5}\ldots\ldots + \frac{1}{x}.$$

Here $u = \frac{1}{x}$; $\int u\,dx = \log x$.

$$\frac{du}{dx} = -\frac{1}{x^2};\ \frac{d^3u}{dx^3} = -\frac{6}{x^4};\ \text{\&c.}$$

$$\Sigma u = \log x + \tfrac{1}{2}x - \frac{1}{12x^2} + \frac{1}{120x^4} - \ldots + C.$$

If $x = 1$, $1 = \tfrac{1}{2} - \tfrac{1}{12} + \tfrac{1}{120} - \ldots\ldots + C$.

Subtracting,

$$\Sigma u = \log x + \tfrac{1}{2}\left(1 + \frac{1}{x}\right) + \tfrac{1}{12}\left(1 - \frac{1}{x^2}\right) - \tfrac{1}{120}\left(1 - \frac{1}{x^4}\right) + \cdots$$

V. To find the sum of the *trigonometric series*,

$$\sin a + \sin 2a + \sin 3a + \ldots\ldots + \sin xa.$$

Here $u = \sin xa$; $\int u\,dx = -\frac{1}{a}\cos xa$.

$$\frac{du}{dx} = a\cos xa;\ \frac{d^3u}{dx^3} = -a^3\cos xa;$$

proceeding, therefore, as in II., we have

$$\Sigma u = \tfrac{1}{2}\sin xa + B\cos xa + C.$$

If $x = 0$, $0 = B + C$.

$$\Sigma u = \tfrac{1}{2}\sin xa + B(\cos xa - 1).$$

If $x = 1$, $\sin a = \tfrac{1}{2}\sin a + B(\cos a - 1)$.

And $B = \tfrac{1}{2}\frac{\sin a}{\cos a - 1} = -\tfrac{1}{2}\frac{\cos\frac{1}{2}a}{\sin\frac{1}{2}a}$.

$$\Sigma u = \tfrac{1}{2}\sin xa - \tfrac{1}{2}\frac{\cos\frac{1}{2}a(\cos xa - 1)}{\sin\frac{1}{2}a}.$$

Reducing to a common denominator and substituting,

$$\Sigma u = \frac{\cos\frac{1}{2}a - \cos(x + \frac{1}{2})a}{2\sin\frac{1}{2}a} = \frac{\sin(x+1)\frac{a}{2}\sin\frac{xa}{2}}{\sin\frac{1}{2}a}.$$

VI. To find the number of *permutations* by logarithms.

$$\Sigma u = \log 1 + \log 2 + \log 3 + \ldots\ldots + \log x.$$

$$u = \log x;\ \int u\,dx = ux - x.$$

$$\frac{du}{dx} = \frac{1}{x};\ \frac{d^2u}{dx^2} = -\frac{1}{x^2};\ \frac{d^3u}{dx^3} = \frac{2}{x^3};\ \text{\&c.}$$

$$\Sigma u = x\log x - x + \tfrac{1}{2}\log x + \frac{1}{12x} - \frac{1}{360x^3} + \ldots\ldots + C.$$

If $x = 1$, $0 = -1 + \tfrac{1}{12} - \tfrac{1}{360} + \tfrac{1}{1380} - \ldots\ldots + C$.

$$C = .918 + = \tfrac{1}{2}\ \text{hyp. log}\ 2\pi.$$

And changing from logarithms to their numbers,

$$1.2.3.4\ldots\ldots(x-1)x = \left(\frac{x}{e}\right)^x \sqrt{2\pi x}\, e^{\frac{1}{12x} - \ldots\ldots}.$$

$$\text{“} \qquad = \left(\frac{x}{e}\right)^x \sqrt{2\pi x}\left(1 + \frac{1}{12x} + \frac{1}{288x^2} - \ldots\ldots\right).$$

Which is the formula known as STIRLING'S theorem; where e is the number 2.718281828, whose hyperbolic logarithm is unity, or whose common logarithm is .434294482; and π the semi-circumference 3.141592653.

The number of *combinations* (u) of $m + n = h$ elements, taken either m or n in a set, is thence easily found; and when the numbers are large, it furnishes the only mode of computation that is practicable.

Since

$$u = \frac{1\,.\,2\,.\,3\,\ldots\ldots\,h}{1\,.\,2\,.\,3\,\ldots\,m\,.\,1\,.\,2\,.\,3\,\ldots\,n},$$

$$u = \frac{h^{h+\frac{1}{2}}\,e^{\frac{1}{12}\left(\frac{1}{h}-\frac{1}{m}-\frac{1}{n}\right)}}{m^{m+\frac{1}{2}}\,n^{n+\frac{1}{2}}\,\sqrt{2\pi}}.$$

Required, for example, the number of combinations of 1,000 different elements taken 470, or, what is the same in respect to number, 530 in a set. The logarithm of the number of combinations sought is readily determined to be 298.6504135; whence the number itself is 4471092 with two hundred and ninety-two other digits annexed. The first five or six figures, however, are generally enough for all practical purposes.

In conclusion, the preceding solutions will be sufficient to show the general nature of the process of summation, and that it brings a most efficient auxiliary to the resources of modern analysis.

The chief objects of Euler's researches on this subject appear to have been "progressions," in which the uniform variable is an exponent; in his own words, "sit terminus generalis, seu is cujus exponens est n." Or as afterwards observed,—"From these examples, it will appear to what progressions the method explained in this dissertation extends; namely, to all those progressions which are comprehended under the general form $(A\,P \div B\,Q)\,x^{an+b}$." (*Petersburg Memoirs, Anno* 1732, pp. 69, 96.) Apparently following this indication, Legendre assumes that the sums to be found shall be of the form e^{mx}, and in conclusion remarks of the result, that it "offers *the possibility* of expressing an integral to finite differences by means of an integral to infinitesimal differences." (*Exercices de Calcul Int.*, Tome II. pp. 145, 152.) Similarly, the author of the article "Probability," *Enc. Brit.*, applying the process to a general exponential term, describes the formula as given "for converting sums of this kind into definite integrals." From all which it would appear, that, in the sense heretofore understood, the process could not be safely employed, except for a series of exponentials. But it is interesting to perceive on the surest grounds that the formula of summation for these is elementary, and the same for all other series of functions; no restrictions of the kind being necessary, save those which arise in some cases from the natural difficulty of the process.

In conclusion, *a shorter mode of demonstration* may be presented, though it exhibits neither the convergency nor the generality of the process in so satisfactory a light as the former. Let $F_{(x)}$ or u denote the general or xth term of the series to be summed; then,

$$u = F_{(x)} = \Sigma F_{(x)} - \Sigma F_{(x-1)}.$$

Denoting the sum of x terms or $\Sigma F_{(x)}$ by s, developing the right-hand member by Taylor's theorem, and transposing,

$$0 = u - \frac{d\,s}{d\,x} + \frac{d^2\,s}{1.2\,d\,x^2} - \frac{d^3\,s}{1.2.3\,d\,x^3} + \frac{d^4\,s}{1.2.3.4\,d\,x^4} - \ldots \quad (1.)$$

Multiplying by $d\,x$, integrating, and transposing s,

$$s = \int u\,d\,x + \frac{d\,s}{1.2\,d\,x} - \frac{d^2\,s}{1.2.3\,d\,x^2} + \frac{d^3\,s}{1.2.3.4\,d\,x^3} - \frac{d^4\,s}{1\ldots5\,d\,x^4} + \ldots C.$$

From which it only remains to eliminate the differentials of s. Adding, therefore, half of equation (1),

$$s = \int u\,d\,x + \tfrac{1}{2}\,u + \frac{d^2\,s}{12\,d\,x^2} - \frac{d^3\,s}{24\,d\,x^3} + \frac{d^4\,s}{80\,d\,x^4} - \ldots + C.$$

Now differentiating equation (1), dividing the result by $12\,d\,x$, and then adding to the last equation,

$$s = \int u\,d\,x + \tfrac{1}{2}\,u + \frac{d\,u}{12\,d\,x} - \frac{d^4\,s}{720\,d\,x^4} \ldots + C.$$

Again, dividing the third differential of equation (1) by $720\,d\,x^3$, and subtracting the result,

$$s \text{ or } \Sigma u = \int u\,d\,x + \tfrac{1}{2}\,u + \frac{d\,u}{12\,d\,x} - \frac{d^3\,u}{720\,d\,x^3} \ldots + C.$$

COMET.

It is stated in the *Boston Evening Traveller* of May 19 and 20, that a new comet has been detected at the Cambridge Observatory, within 15° of the pole;—in right-ascension about $22\frac{1}{2}$ hours, declination 75° north. I have, however, received no information to this effect from the astronomers of the Observatory.

G.

Cambridge, May 22.

OBSERVATIONS OF THE SUN, OF EGERIA, AND OF FLORA,

MADE WITH THE MERIDIAN-CIRCLE OF THE ALTONA OBSERVATORY.

By A. SONNTAG.

[Communicated by Dr. PETERSEN.]

SUN.

1852.	App. α	$\Delta\alpha$	$\frac{1}{2}t$	Δt	Geoc. δ	$\Delta\delta$	Obs. r	Δr
	h. m. s.	s.	m s.	s.	° ′ ″	″	′ ″	″
Jan. 5	19 2 20.66	—0.11	1 10.79	+0.04	—22 41 2.6	+0.1	16 14.8	+2.4
6	19 6 43.80	+0.12	10.62	+0.15	22 34 13.4	—3.1	14.6	+2.7
20	20 7 13.11	+0.12	9.50	+0.08	20 14 33.9	—0.8	16.8	—0.4
Feb. 20	22 12 20.93	—0.31	6.08	+0.09	11 6 45.0	—1.8	10.8	+0.6
21	22 16 10.77	—0.13	6.06	+0.02	10 45 14.0	—0.4	10.5	+0.7
23	22 23 48.65	+0 08	6.00	—0.10	10 1 40.5	+0.2	10.2	+0.5
24	22 27 36.60	+0.20	5.75	+0.05	9 39 39.2	—0.1	9.3	+1.2
25	22 31 24.37	—0.11	5.73	—0.01	9 17 28.5	—1.2	7.9	+2.4
Mar. 2	22 53 56.87	—0.04	5.28	—0.03	7 1 51.2	—1.9	7.8	+1.0
4	23 1 23.69	—0.17	5.08	+0.03	6 15 47.6	—2.3	5.4	+2.9
5	23 5 6.33	—0.16	5.09	—0.04	5 52 38.9	—1.6	9.1	—1.0
6	23 8 48.10	+0.30	5.08	—0.09	5 29 26.5	+0.2	7.7	+0.1
17	23 49 10.92	+0.16	4.41	+0.09	1 10 20.7	—1.4	3.0	+1.9
19	23 56 28.52	—0.01	4.60	—0.15	—0 22 55.2	—1.7	5.2	—0.8
20	0 0 6.91	+0.10	4.54	—0.11	+0 0 48.5	—3.3	4.9	—0.8
21	0 3 45.26	+0.13	4.42	0.00	0 24 28.0	—1.4	2.6	+1.2
22	0 7 23.50	+0.17	4.37	+0.03	0 48 10.3	—3.5	16 1.8	+1.7
April 2	0 47 22.69	+0.09	1 4.50	—0.05	+5 5 24.9	+0.1	15 57.7	+2.7

The observations are compared with the Berlin *Jahrbuch*. $\frac{1}{2}t$ is half the duration of the transit; r is the vertical semidiameter. The differences are C. — O.

EGERIA.

1852.	M. T. Altona.	⑬ App. α	⑬ Geoc. δ
	h. m. s.	h. m. s.	° ′ ″
Feb. 23	14 2 46	12 15 8.23	+23 35 56.6
24	13 58 1	14 18.81	23 40 51.5
29	13 33 54	9 50.84	21 3 24.9
Mar. 1	13 29 1	12 8 53.31	21 7 26.3
13	12 29 17	11 56 17.48	21 38 47.9
14	12 24 15	55 11.64	21 39 48.0
15	12 19 13	51 5.67	24 40 35.2
19	11 59 6	49 41.24	24 40 24.8
20	11 54 5	48 35.82	24 39 48.3
21	11 49 4	47 30.61	24 38 49.1
25	11 29 8	11 43 17.31	+24 31 50.5

The observation of March 19, especially the declination, is uncertain.

FLORA.

1852.	M. T. Altona.	⑧ App. α	⑧ Geoc. δ
	h. m. s.	h. m. s.	° ′ ″
Feb. 23	14 41 53	12 54 20.98	+3 14 23.6
24	14 37 29	53 52.51	3 20 55.2
Mar. 1	14 10 39	50 27.51	4 2 35.9
12	13 18 51	42 3.86	5 25 56.3
13	13 14 3	41 10.85	5 33 38.8
19	12 44 55	35 37.46	6 19 32.0
20	12 40 2	34 40.16	6 26 59.2
21	12 35 8	33 41.98	6 34 21.0
25	12 15 29	29 46.61	7 3 0.8
April 2	11 36 15	12 21 57.99	+7 54 7.0

The α, March 1, is possibly 1ˢ in error.

All the preceding observations have been corrected for parallax.

SIXTEENTH ASTEROID.

THIS planet has been observed by Mr. **FERGUSON** with the Equatorial of the Washington Observatory. The observations of May 6 and 7 were received from Lieutenant **MAURY**, Superintendent of the Observatory, just as the last number of the *Astronomical Journal* was printing. They are as follows: —

OBSERVATIONS OF THE SIXTEENTH ASTEROID.

[Corrected for refraction.]

Date.	M. T. Washington.	No. Obs.	Comparison-Star.	⑯ — *		⑯'s apparent	
				Δα	Δδ	α	δ
	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″
May 6	11 50 16.1	4	Weisse IX. 1259	—3 22.39	+0 4.30	9 55 16.42	+13 31 18.37
7	8 14 30.1	9	Rümker 3061	—1 16.78	—5 18.35	9 55 39.94	+13 29 27.67

Adopted Mean Places, 1850.0, *of Comparison-Stars.*

*	Mag.	α	δ
		h. m. s.	° ′ ″
Weisse IX. 1259	8	9 58 32.19	+13 30 40.93
Rümker 3061	9	9 56 50.09	+13 34 21.59

The planet is estimated of the (10.2) magnitude. On the night of the 6th, (one of the finest nights of the year,) it showed a little fainter than the small star of 1496 of the *Mensuræ Micrometricæ*, and not much less than **WEISSE** IX. 1284, which **BESSEL** estimated as (9.10).

SEVENTEENTH ASTEROID.

A NEW and very faint planet was detected near *Flora*, on the 17th of April, at Bilk, by Mr. **LUTHER**, the Director of that Observatory, — who made the following observations: —

1852.	M. T. Bilk.	α	δ
	h. m. s.	° ′ ″	° ′ ″
April 17	10 37 39	180 38 24	+8 49 2
21	10 0 43	180 4 59	+8 59 27

Dr. **PETERSEN** has kindly communicated, under date of May 4, the following additional observations: —

VIENNA.

1852.	M. T. Vienna.	α	δ	No. Comp.
	h. m. s.	h. m. s.	° ′ ″	
April 26	8 38 59.5	11 58 7.51	+9 7 9.7	4
28	8 55 23.7	11 57 24.52	+9 8 40.7	8

ALTONA.

1852.	M. T. Altona.	α	δ	
	h. m. s.	h. m. s.	° ′ ″	
April 25	9 42 24	11 58 29.36	+9 6 2.5	Mer. Cir.
	10 39 55	58 28.90	6 6.3	6 Comp.
26	9 33 22	58 6.01	7 6.5	10 "
	9 38 4	11 58 5.38	+9 7 7.6	Mer. Cir.

HAMBURG.

1852.	M. T. Hamburg.	α	δ	
	h. m. s.	° ′ ″	° ′ ″	
April 23	10 35 13.2	179 50 10.7	+9 3 18.0	10 Comp.

Dr. **BRÜNNOW** in Berlin has computed the orbit from observations of April 17, 21, and 25.

Epoch 1852, April 17 0, Mean Time Berlin.

M	303° 57′ 38″.6
π	259 48 29.3
☊	121 27 33.5
i	5 37 40.9
ϕ	7 47 29.1

Log. a	0.402348
μ	884″.0650

This asteroid was observed at Washington, on the 18th and 19th instant, by Mr. FERGUSON, who estimates it as apparently of the 10.5 magnitude. The observations communicated by Lieutenant MAURY give

Date.	M T. Washington.	No. Comp.	Comparison-Star.	17 — ✱ $\Delta\alpha$	17 — ✱ $\Delta\delta$	17's apparent α	17's apparent δ
1852.	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″
May 18	10 13 27.6	2	Weisse XI. 947	+1 17.46	—5 20.18	11 56 29.50	+8 33 22.95
19	12 16 11.1	9	"	+1 33.21	—9 38.61	11 56 45.23	+8 29 4.59

Adopted Mean Place of WEISSE XI. 947, *for* 1850.0.

✱ α	✱ δ
11h. 55m. 5s.2	+8° 39′ 25″.23

G.

ON THE ORIGIN OF THE FORMS AND THE PRESENT CONDITION OF SOME OF THE CLUSTERS OF STARS AND SEVERAL OF THE NEBULÆ.

BY STEPHEN ALEXANDER,

PROFESSOR OF MATHEMATICS AND ASTRONOMY IN THE COLLEGE OF NEW JERSEY.

(*Continued from page* 115.)

ADMITTING the annular form, there also would seem to be some trace of appendages to the ring at the one extremity, not wholly unlike those in *Fig.* 29.

The conjecture of LORD ROSSE, that the nebula, if not annular, may have the other form spoken of, coincides with that of SIR JOHN HERSCHEL, who says : —

" It is not impossible that the real constitution of these bodies may be that of hollow spherical or elliptical shells, of which the borders appear brighter than the interior, by reason of the greater thickness of the luminous matter, or starry stratum, traversed by the visual ray. Certain it is that the interior of M. 57" (our *Fig.* 29) " is very far from totally dark, and that so much light exists within the annuli of IV. 11 and IV. 13, that they are set down by my father as planetary nebulæ, and the latter is even described by him as 'of equal light.' The delicate and beautiful annulus h. 3680 appears, indeed, to be devoid of any interior illumination, — but the object is so faint, that a nebulosity filling in the center, and bearing no greater proportion in respect of density to the ring than in the case of M. 57, could not have been perceived. The tenuity of the ring, as well as the feebleness of central illumination, will of course in our hypothesis be proportioned to the thinness of the shell, and the law of degradation of its light will be determined by the ratio of the radii of its inner and outer surfaces, as well as by the law of density of the strata of which it consists. IV. 11 and IV. 13 would therefore seem to have the central hollow smaller in proportion than either of the other two. V. 19 is probably not a hollow shell, but a real annulus, whose actual dimensions must be indeed enormous, being described by my father as more than a quarter of a degree in length, which, supposing it *only* as remote as 61 *Cygni*, would correspond to a real diameter 1300 times exceeding that of the earth's orbit." *

Whether the *material* of certain peculiar nebulæ and clusters may not *heretofore* have been arranged in forms such as that here described will be considered hereafter. It will be observed, however, that even if we admit that the nebulæ in question have *now* the form of hollow shells, the appendages visible in *Fig.* 29 must still be regarded as *extraneous developments*, presenting serious difficulties in the way of any hypothesis which should regard the case as one of dynamical equilibrium ; though very consistent with the supposition of an equilibrium destroyed by a too rapid rotation of the primitive mass ; of which catastrophe those appendages are to be regarded as the first and minor results. Their projection outwards and their comparative faintness would then both be facts in place, and their form in other respects exhibit no little correspondence with that which should in such a case exist.

The few instances already noticed include all the nebulæ which have been recognized as annular, in the strict sense of the term, among more than four thousand whose places have been determined. The planetary nebulæ, in so far as they have been partially resolved by LORD ROSSE, are more complicated.

H. 2552 is represented in *Fig.* 17, which is a copy of SIR JOHN HERSCHEL'S (*Results of Observations*, *&c.*, Plate IV. Fig. 1).

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* *Results of Observations made at the Cape*, *&c.*, p. 24.

In the Remarks on the Southern Catalogue, this nebula is classified with that represented in our *Fig.* 11 (alluded to at p. 101). Both nebulæ are spoken of as "*Annular nebulæ with centers*"; and it is added, that, "although the nebulous ellipse into which the annulus is obliquely projected is incomplete at the extremities of its longer axis, yet its general form cannot be mistaken."[*]

All the principal features presented in the hypothetical description of this order of nebulæ seem to be singularly well preserved in this instance; viz., *the dense equatorial ring; the thin plate of inferior density* still indicating the *plane of the equator;* and *the central condensation.*

The ring, however, would seem to have been unequally condensed before it broke; as may also have occurred in some other rare instances, in which traces of a *preëxisting* annular form seem still to be visible. Among these are the "convoluted nebulæ."[†]

Order 2d. Convoluted Nebulæ.

Although, in the case of the annular nebulæ, the rupture of the equatorial ring seems to have been wellnigh simultaneous, yet that would not occur of course. A rupture even so extensive as to destroy the continuity of the ring may at first have been local; especially if the ring, in consequence of unequal cooling, had become somewhat overloaded with a more condensed portion toward one side; a result by no means improbable, but rather the contrary.[‡]

The changes which would successively result in consequence of such a local rupture are represented in *Figs.* 22 to 25 inclusive. *Fig.* 20 gives a polar view of the ring itself, which, as shown in the remarks introductory to this class, may or may not have had a less dense portion within and adhering to it.

The *angular* velocity, as in previous cases, becoming accelerated as the ring cooled, the various repulsive forces in action would tend to throw off the successive portions of the ring in directions approaching to those represented in *Fig.* 21, but the first extensive rupture of the ring, being a local one, take place as represented in *Fig.* 22.

The *angular* velocity of the ejected and partially torn off portions (*a* and *b*) being then diminished, they would in their subsequent rotation *relatively* fall behind their (now) interior and adjacent portions, as is shown at *a* and *b* in *Fig.* 23. The angular velocity of those adjacent portions would soon itself also be diminished, if the ejected portions yet adhered; but the *very* remote portions of the ring toward the other side would be insensible to such an influence until the inertia of the enormous mass would permit the same to be felt there.

After a time, which might be soon in comparison with some of the other great changes, the portion opposite to the break (*Fig.* 23) being more relieved from the central force than the other portions, in consequence of some of the changes already described, would recede from the center beyond the portions adjacent to itself, and *its angular* velocity being thus specially diminished, a partial *fold* as well as out-jutting might occur in that region; as represented in the figure.

The changes thus begun would progress, and the distortion of the figure of the mass be aggravated, very much in the manner represented in *Fig.* 24.

The retardation of the *angular* velocity of some portions above others, would tend to render the distribution of density unequal, very much after the manner indicated in *Fig.* 23; aside from the previous accumulation which, as already stated, might have occasioned the local rending of the ring.

In *Fig.* 25 the distortion of form is still greater than in *Fig.* 24; the out-jutting and fold opposite to the break have become more complete; the portion *b* more diffused, and left farther behind that which preceded it in the rotation of the ring; the portion *a* folded farther back; and the partial condensations more distinct and perfect. The folding back of *a* might then be aided by the attraction of the adjacent portion, above it in the figure; and the other distortions, in their measure, also be aggravated in like manner; and the figure thus suffer an irregular and partial collapse, wherever the projectile force at the first rupture had been so far overcome, or the direction of the motion with respect to the resultant of attractive force so far changed, or both, that the part thus affected could fall somewhat toward those adjacent to it.

At *a*, moreover, the folding together and accumulation might be decidedly greater than elsewhere; the overloading of the region of the ring from which *a* was ejected having caused the rending to take place there, and the accumulation having progressed afterward. In accordance with what has already been intimated, the divellent force of the more condensed part may also have diminished the density of other portions of the ring, before the rending occurred.

The various changes now described might be quite sufficient to break up the continuity of the material subjected to them; aided as those changes also might be by the developments consistent with a chemical change of *state*, or others analogous in their effects; — in accordance with the intimation in the remarks introductory to Class I. Thus, as in the several cases of the spirals, &c., the mass would throughout be rent into fragments, and ultimately into comparative drops, i. e. stars, or the separate masses which were to form stars.

The hypothetical form in *Fig.* 25 is extensively *realized* in the instance of the nebula represented in *Fig.* 26; a copy from one of Sir John Herschel's figures of M. 17, H. 2008 (*Phil. Trans. for* 1833, Plate XII. Fig. 35). *Fig.* 27 is copied from his other figure of the same nebula, seen under more favorable circumstances (*Results of Observations made at the Cape, &c.*, Plate II. Fig. 1).

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[*] *Results of Observations, &c.*, p. 20.

[†] Sir John Herschel's term.

[‡] Analogous to one of the earliest of the progressive changes in the formation of a planet from a ring, in the manner supposed by the *nebular hypothesis.* See Laplace, *Exposition du Système du Monde*, 5^e edition, Tome II. p. 438.

On the occasion on which the first delineation was made, some of the features would seem to have been more distinctly seen; although it is stated, that, "owing to the deficiency of micrometrical measurements, its form is far from accurately expressed in that representation."[*] The deviation in this respect is corrected in *Fig.* 27; and with this agrees the plate accompanying the account of Messrs. MASON and SMITH's *Observations of Nebulæ with a Fourteen-feet Reflector* (*Trans. of Amer. Phil. Society*, New Series, Vol. VII. Plate VI.); with the exception of "the fainter horse-shoe" shown in *Fig.* 27, which was not seen by them with the smaller telescope which they employed, and that the central part of the larger "nebulous knot" is not represented in their plate as circular, but elongated toward the opening of the two great branches.[†]

In both the figures we may see the irregular distribution of density, and also the various positions of the several portions, which were deduced as probable consequences in the hypothetical case. Admitting it to have been realized in this example, the overloading of the ring must have occurred near the region which furnished the brighter portion of the existing nebula, and the larger "nebulous knot" have undergone changes such as those suggested by the nebular hypothesis, or such as those heretofore supposed in the cases of the elliptic nebulæ, globular clusters and spirals; — in part, perhaps, before the ring broke. The smaller "nebulous knot" is found near to the position assigned to the fold in the hypothetical ring, before described.

The very great density and extent withal of the less curved branch, or "Messier's streak," are more fully accounted for by the appearance of the "fainter horse-shoe attached" to it. This does not seem to have been noticed by any observer besides SIR JOHN HERSCHEL. It was seen by him on two occasions, "but only delineated in its true form and magnitude" on one of them. He further observes: "It merits, however, a more particular attention than I was then able to bestow on it, as it is possible that yet other convolutions may exist."[*]

This "fainter horse-shoe" would seem to indicate the previous existence of another ring, — having a rotation in a direction, as near as might be, opposite to that of the former, — having, besides, its resulting nebula very possibly more distant from us; and the convolutions of the same projected in part behind those of the other nebula.

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[*] *Results of Observations made at the Cape, &c.*, p. 7.

[†] It appears from SIR JOHN HERSCHEL's note (*Results of Observations, &c. at the Cape*, p. 8), that many of the features delineated in *Fig.* 26 are also to be found in DR. LAMONT's figure, "in his Academical Thesis on Nebulæ, read before the Bavarian Academy, August 25, 1837."

[*] *Results of Observations, &c. at the Cape*, p. 8.

(*To be continued.*)

NOTICE.

PROFESSOR BUSCH of the Königsberg Observatory has requested me to state in the *Astronomical Journal*, that a few extra copies of the recently engraved portrait of BESSEL have been struck off, and are now for sale in Leipsic. This exquisite line engraving is by the eminent artist, MANDEL, in Berlin, and has been executed by authority of the Prussian government to ornament the next volume of the *Königsberg Astronomical Observations.* As a work of art it may almost be said to be unsurpassed.

I have also been requested by the publishers to mention, that a new edition of the lithographic portrait of GAUSS has been issued by Messrs. VANDENHOECK and RUPRECHT, in Göttingen.

G.

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NOTICE.

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OBSERVATIONS OF HYGEA,

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By Mr. JAMES FERGUSON.

[Communicated by Lieutenant Maury.]

[Corrected for refraction.]

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	⑩ — *		⑩'s apparent		A.
				Δ α	Δ δ	α	δ	
1851.	h. m. s			m. s.	′ ″	h. m. s.	° ′ ″	
Aug. 29	10 41 26.5	3	B. A. C. 177	—3 54.10	+ 0 32.03	0 29 38.66	+8 33 13.52	9
Sept. 19	9 15 46.0	3	" 66	+3 27.36	+ 5 36.79	16 25.82	7 27 35.72	8
21	10 21 42.6	9	" 66	+1 58.38	— 2 58.64	14 56.85	7 19 0.45	10
Oct. 1	11 15 12.1	2	Weisse O. 192	—3 53.59	+ 5 58.84	7 36.85	6 33 30.21	9
	11 40 24.5	3	"	—3 55.31	+ 5 54.44	7 35.13	6 33 25.83	9
6	10 19 2.9	6	Weisse O. 89	—1 19.65	+ 5 46.23	4 5.82	6 10 3.64	8
		6	" 104	—2 23.41	+ 6 46.91	4 6.04	6 10 4.22	8
7	10 27 39.0	2	" 89	—2 1.40	+ 0 57.85	3 24.07	6 5 13.31	10
		2	" 104	—3 4.96	+ 1 58.59	3 24.49	6 5 15.95	10
8	10 38 46.5	4	Rümker 11970	+3 14.20	— 2 36.70	2 43.14	6 0 29.21	9
9	9 43 55.3	6	"	+2 35.29	— 7 8.96	2 4.24	5 55 57.00	10
10	9 55 41.1	5	"	+1 55.26	—11 53.51	1 24.21	5 51 12.47	9
		5	Weisse XXIII. 1251	+0 35.01	+ 3 41.85	0 1 24.13	5 51 12.29	9
14	9 28 42.7	10	Rümker 11941	+1 46.08	— 9 11.63	23 58 52.78	5 32 49.63	9
		10	Weisse XXIII. 1180	+1 37.26	— 2 43.32	58 52.48	5 32 50.35	9
19	9 38 22.1	6	Rümker 11913	+0 48.25	— 2 4.33	55 58.31	5 10 31.19	10
20	10 20 9.1	6	"	+0 15.21	— 6 30.01	55 25.26	5 6 8.52	10
27	10 8 5.3	5	Weisse XXIII. 1032	+1 53.48	+ 3 26.91	52 6.55	4 38 17.29	8
Nov. 1	10 3 37.9	10	"	+0 2.74	—13 54.30	50 15.76	4 20 56.04	8
7	9 26 23.7	6	Rümker 11777	—0 32.01	+ 9 35 62	48 39.65	4 3 37.43	10
11	9 47 39.9	3	"	—1 13.01	+ 0 4.44	47 58.62	3 54 6.10	8
28	8 21 55.8	5	"	—0 50.06	—18 47.02	48 21.33	3 35 13.87	10
Dec. 1	7 22 30.3	6	Rümker 11766	+0 28.15	—12 36.27	49 10.18	3 35 31.90	8
18	8 11 55.6	4	Weisse XXIII. 1110	+1 48 95	—16 51.03	55 49.16	3 56 53.33	8
19	7 18 18.7	4	"	+2 19.36	—14 42.33	55 19.56	3 59 1.58	8
23	7 25 27.8	3	Weisse XXIII. 1258	—2 36.01	— 7 32.60	23 58 36.12	4 8 44.63	7
26	7 5 33.4	3	"	—0 45.76	+ 1 11.38	0 0 26.42	4 17 28.40	7
		3	Weisse XXIII. 1260	—0 46.18	— 1 26.34	0 26.60	4 17 25.50	7
1852.								
Jan. 7	7 39 0.5	5	Santini 10	+0 55.78	— 1 21.72	8 57.06	4 58 45.87	7
	8 47 12.9	3	"	+0 57.96	— 1 4.74	0 8 59.14	+4 59 2.85	7

Adopted Mean Places, 1850.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
		h. m. s.	° ′ ″	
(1) B. A. C. 177 ; Weisse O. 579 ; Santini 37	7	0 33 27.42	+8 32 9.23	Mean of Weisse and B. A. Catalogue.
B. A. C. 66 ; Weisse O. 223 ; Santini 17 ; Gr. 12 Y. C. 16	6.7	0 12 52.86	7 21 23.32	Mean of Weisse, Santini, and Gr.12 Y. C.
Weisse O. 192	9	0 11 21.79	6 26 54.84	Weisse's Catalogue.
" 89	9	0 5 19.82	6 3 40.19	" "
" 101	9	0 6 23.80	6 2 40.39	" "
Weisse XXIII. 1222 ; Rümker 11970 ; Santini 1676	8	23 59 23.31	6 2 28.78	Mean of Weisse, Rümker, and Santini.
Weisse XXIII. 1251	8	0 0 43.46	5 46 53.30	Weisse's Catalogue.
Weisse XXIII. 1178 ; Rümker 11941	8	23 57 1.09	5 41 23.91	Mean of Weisse and Rümker.
Weisse XXIII. 1180	9	23 57 9.61	5 34 56.33	Weisse's Catalogue.
(2) Weisse XXIII. 1142 ; Rümker 11913	8.3	23 55 4.46	5 12 1.16	Mean of Weisse and Rümker.
Weisse XXIII. 1032	9	23 50 7.53	4 34 13.03	Weisse's Catalogue.
Weisse XXIII. 1006 ; Rümker 11777	7.8	23 49 6.21	3 53 24.83	Rümker's Catalogue.
Weisse XXIII. 994 ; Rümker 11766	9	23 48 36.83	3 47 32.35	" "
Weisse XXIII. 1110	9	23 53 55.13	4 13 12.18	Weisse's Catalogue.
" 1258	8.9	0 1 7.09	4 15 42.89	" "
" 1260	8.9	0 1 7.69	4 18 17.69	" "
Santini 10	7.8	0 7 56.24	+4 59 34.24	Santini's Catalogue.

(1) The α of Weisse O. 579 is five seconds too small. The error is in the reduction to 1825. *Vide* Bessel's Zone III.

(2) Bessel estimates this star at 9. Rümker at 7. At the time of observation it was estimated at (8.3).

FROM LETTERS OF PROFESSOR D'ARREST TO THE EDITOR.

Leipsic, 1852, May 1.

Observations of De Gasparis's *new Planet, made at the Leipsic Observatory.*

1852.	M. T. Leipsic.	⑯ α	⑯ δ
	h. m. s.	° ′ ″	° ′ ″
April 19	9 22 54.6	147 36 49.1	+13 48 44.5
20	11 22 22.8	147 38 52.6	13 48 36.1
21	9 27 41.9	147 40 48.1	+13 48 16.6
April 22	10 30 38.1	147 43 27.6	+13 47 44.3
23	10 8 45.2	147 46 11.9	+13 47 9.4

The planet resembles a star of the 12 magnitude. An observation of April 25, and the places of Luther's (seventeenth) asteroid, are not yet reduced. The latter is equal in brightness to a star of the 11 magnitude.

*Collected Observations of Thetis.**

1852.	M. T.	Place.	⑰ α	⑰ δ
	h. m. s.		° ′ ″	° ′ ″
April 22	10 5 43.0	Bonn	179 57 24.2	+9 1 30.6
22	12 54 46.0	Bonn	179 56 35.3	9 1 44.5
22	12 11 58.7	Berlin	179 56 45.5	9 1 22.1
23	9 37 26.0	Bonn	179 50 50.0	9 3 31.0
23	10 35 13.2	Hamburg	179 50 10.7	+9 3 18.0

I have found, while searching for comets, a new nebula in *Antinous*, not given in the published catalogues. The object is equal in brightness to a first-class nebula, about three minutes in diameter. Its approximate position is for 1852,

$$\text{R.A.} = 285^\circ\ 55'\ 8''.2 \qquad \text{Dec.} = +0^\circ\ 46'\ 7''.7$$

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* This name has been given to the seventeenth asteroid by Professor Argelander, to whom Mr. Luther had delegated his rights as discoverer. The sixteenth asteroid has received the name of *Psyche*. — G.

1852, *May* 12.

I have made a little cometary discovery, namely, elements by **Burckhardt** of *a comet of* 1816, which has been entirely omitted in our catalogues. I will give the matter in detail in the *Astronomische Nachrichten*. The elements are, as given by **Burckhardt**,

T	1816, March 1, 8ʰ· 27ᵐ· Paris.
π	267° 35′ 33″
☊	323 14 56
i	43 5 26
q	0.048503

Motion Direct.

H. D'ARREST.

FIRST COMET OF 1852.

1. *Observations.*

Mr. G. P. **Bond** has communicated the following observations of the comet recently discovered by him. They were made with the Great Cambridge Equatorial, and referred to the mean equinox of 1852.0.

1852.	M. T. Cambridge. h. m. s.	☄ α h. m. s.	☄ δ
May 18	13 5 45.1	22 28 55.51	+74° 35′ 53″.2
19	9 36 9.0	22 26 12.47	76 53 15.2
20	9 37 18.0	22 21 38.85	+79 31 47.8

Mr. **Bond** describes the comet as rather faint, round, and with a diameter of about two minutes of arc.

2. *Elements.*

Mr. I. B. **Bradford** has computed a parabolic orbit from the three Cambridge observations given above. The elements are for the mean equinox of 1852.0, and Greenwich mean time.

Inclination,	48° 54′ 41″.2
Longitude of Perihelion,	280 3 26.0
" Node,	318 15 54.3
Perihelion Distance,	0.908154
Time of passing Perihelion,	April 19.67

Motion Retrograde.

Mr. **Bond** has communicated the following elements, computed from observations May 18, 21, and 25.

Perihelion Passage, April 19.5446, Greenwich M. S. T.

Longitude of Perihelion,	280° 17′ 42″	Mean Equinox,
" Node,	317 17 54	1852.0
Inclination,	48 32 0	
Log. of Perihelion Distance,	9.95645	

Motion Retrograde.

"The comet is receding from the earth and from the sun, and will not probably be long visible; it must have been brighter in the early part of the month. The reduction of our later observations is delayed for want of the places of the comparison-stars, of which the catalogues contain very few in the regions about the pole where the comet now is."

Mr. C. W. **Tuttle** has also computed elements, as follows: —

T	April 19.65325, Greenwich M. T.	
π	279° 46′ 21″	Equinox 1852 0.
☊	317 26 55	
i	49 23 36	
Log. *q*	9.95824	

Motion Retrograde.

This comet was first discovered by Dr. **Petersen** in Altona, May 17, who has communicated the following copy of his announcement, published the ensuing day in an appendix to the *Astronomische Nachrichten*: —

"Last evening about 11 o'clock, I discovered in the constellation *Cepheus* a small telescopic comet, which is moving with considerable rapidity toward the north pole. The sky unfortunately became obscured after midnight, and the light of the comet was consequently so much enfeebled, that the later observations are entitled to but little confidence. In the absence of an accurate position for the comparison-star, I have computed the following approximate apparent position, and hourly proper motion for the comet from the observations.

1852.	M. T. Altona. h. m. s.	☄ α h. m. s.	☄ δ
May 17	12 43 25	22 31 38.45	+71 13′ 4″.6
Hourly motion,		—3ˢ.06	+7′ 22′.5."

G.

OBSERVATIONS ON THE SATELLITES OF SATURN,

MADE AT THE OBSERVATORY OF HARVARD COLLEGE.

By G. P. BOND.

Enceladus.

1848, October 5th, 9^{h} 23^{m}, M. S. T. *Enceladus* follows *Saturn's* nearest limb by $28''.12$ by 4 measures.

October 5th, 10^{h} 28^{m}, M. S. T. *Enceladus* follows *Saturn's* nearest limb by $26''.26$ by 2 measures. At 12^{h} the object observed was still in the plane of the ring, and must have been a satellite. Good definition.

October 7th, 8^{h} 41^{m}, M. S. T. *Enceladus* precedes *Saturn's* nearest limb by $26''.11$ by 2 measures. "The definition to-night is exceedingly fine; the seven old satellites are distinctly seen; even *Mimas* is not to be overlooked. The object observed was watched for two hours, and was undoubtedly a satellite."

October 9th, 7^{h} 31^{m}, M. S. T. *Enceladus* follows *Saturn's* nearest limb by $17''.36$ by 2 measures. "Undoubtedly a satellite, as its motion is sensible." "All the old satellites are visible, though the moon is in the immediate neighborhood of the planet. *Mimas* is the most difficult, but yet certainly seen. *Titan* appears as a star of the 8th magnitude, *Enceladus* as a star of the 16th, and *Mimas* of the 18th magnitude."

October 12th, 8^{h} 0^{m}, M. S. T. *Enceladus* follows *Saturn's* following limb by $21''.05$ by 3 measures. "Bright moonlight. *Enceladus* equal to a star of the 15th magnitude. The new satellite is visible."

October 20th, 8^{h} 11^{m}, M. S. T. *Enceladus* follows *Saturn's* preceding limb by $16''.35$ by 3 measures.

October 23d, 8^{h} 38^{m}, M. S. T. *Enceladus* follows *Saturn's* preceding limb by $37''.32$ by 3 measures. All eight satellites are well seen.

November 2d, 7^{h} 22^{m}, M. S. T. *Enceladus* precedes *Saturn's* preceding limb by $16''.53$ by 3 measures. Bad vision. The object was observed for *Mimas*, but its place agrees with the calculated place of *Enceladus*.

November 3d, 8^{h} 33^{m}, M. S. T. "*Enceladus* follows *Saturn's* following limb by $11''.93$ by 4 measures. Very good vision."

November 22d, 7^{h} 40^{m}, M. S. T. "*Enceladus* follows *Saturn's* preceding limb by $45''.13$ by 3 measures. Most perfect definition."

1849, January 12th, 7^{h} 26^{m}, M. S. T. "*Enceladus* precedes *Saturn's* preceding limb by $7''.25$ by 5 measurements. *Enceladus* is at the extremity of the ansa, and appears exactly in the plane of the ring."

1852, January 24th, 8^{h} 10^{m}, M. S. T. "*Enceladus* is at its greatest elongation following *Saturn*. The edge of the ring is very nearly central between it and the edge of the ball, and it is precisely in the prolongation of the major axis of the ring. At 9^{h} 5^{m} it appears below the axis, retaining very nearly the same distance, and was therefore a satellite."

January 26th, 6^{h} 2^{m}, M. S. T. *Enceladus* precedes the outer edge of the preceding ansa by $10''.23$ by 4 measures.

January 26th, 6^{h} 30^{m}, M. S. T. *Enceladus* precedes the ansa by $9''.63$ by 6 measures. C. W. TUTTLE observed.

January 26th, 8^{h} 22^{m}, M. S. T. *Enceladus* precedes the ansa by $12''.90$ by 10 measures. C. W. TUTTLE observed.

February 2d, 6^{h} 11^{m}, M. S. T. *Enceladus* precedes *Saturn's* center by $34''.45$ by 2 measures from the preceding and 2 from the following limb.

February 2d, 7^{h} 42^{m}, M. S. T. *Enceladus* precedes *Saturn's* center by $32''.12$ by 2 measures from the preceding and 2 from the following limb. "As the atmosphere was much disturbed, and the moon bright, the observations are made with difficulty." Two hours later the satellites had moved enough to establish their identity.

February 3d, 9^{h} 15^{m}, M. S. T. *Enceladus* is below the axis of the ring, and on a line perpendicular to the axis at the preceding ansa. "Images are tranquil, but it is nearly full moon."

February 4th, 6^{h} 32^{m}, M. S. T. "*Enceladus* follows the following ansa by $13''.10$ by 10 measures of double distance, and is almost precisely in the line of the major axis, perhaps $0''.5$ above it. The seeing is not good, and the telescope is affected by a high southerly wind, which makes the observations difficult. At 10^{h} P. M. looked again for the satellite, but *Saturn* was too low for it to be seen."

February 7th, 6^{h} 15^{m}. *Enceladus* follows the preceding ansa by $5''.03$ by 2 measures of double distance. It is about $8''$ apparently *below* the axis. There is no doubt of its identity as it keeps up with the planet in its motion. It is blowing half a gale of wind, yet the vision is tolerably good.

February 17th, 6^{h} 59^{m}. *Enceladus* precedes the preceding ansa by $11''.61$ by 4 direct measures and 3 of double distance.

Tethys. 1852.

1852, January 27th, 7^{h} 2^{m}. *Tethys* follows *Saturn's* center by $22''.28$ by 6 measures from the preceding and 3 from the following limb. "Measures pretty good. Two hours later the air became so much disturbed, that nothing could be seen of the satellite."

January 29th, 6^{h} 21^{m}. *Tethys* in apparent inferior conjunction with *Saturn*. A very exact observation made by referring the place of the satellite to the points where the outer edge of the ring intersects the ball. The satellite is distant from the N. limb by the same amount that the edge of the ring is within the limb.

January 29th, 9h. 33m.. *Tethys* precedes *Saturn's* center by 17″.79 by 2 measures from the preceding and 2 from the following limb.

February 2d, 6h. 24m.. *Tethys* precedes *Saturn's* center by 29″.69 by 2 measures from the preceding and 2 from the following limb.

February 2d, 7h. 34m.. *Tethys* precedes *Saturn's* center by 34″.06 by 4 measures, 2 from each limb.

February 2d, 9h 50m.. *Tethys* precedes *Saturn's* preceding limb by 32″.75 by 3 measures. “Satellite is near its greatest elongation; a little short of it.” “Observations made with difficulty, from the disturbed state of the atmosphere.”

February 4th, 6h. 46m.. *Tethys* precedes the center of *Saturn* by 39″.14 by a single measurement direct from the center of the ball. “Not very good.”

February 5th, 7h. 22m.. *Tethys* follows the following ansa by 21″.81 by a single pretty good measure. Vision not good.

February 7th, 6h. 25m.. *Tethys* follows the following ansa by 22″.89 by 3 measures of double distance. “Satellite is near its elongation, being less than 1″ of arc below the axis. Wind very annoying.”

February 14th, 6h. 54m.. *Tethys* follows *Saturn's* preceding limb by 3″.53 by 3 measures of double distance.

February 16th, 7h. 2m.. *Tethys* follows *Saturn's* following limb by 2″.45 by 2 measures.

February 16th, 6h. 48m.. *Tethys* south of *Saturn's* S. limb 1″.86 by 2 measures.

February 16th, 7h. 25m.. *Tethys* south of *Saturn's* S. limb 1″.08 by 2 measures.

February 16th, 7h. 23m.. *Tethys* is north of *Dione*, in a direction perpendicular to the axis of the ring 4″.26. The line joining *Tethys* with *Dione* is inclined to the axis at 7h. 16m. by 85° 5′ by 3 measures. At 7h. 31m. this angle was 87° 20′ by 2 measures.

The above distances were measured in the direction of the major axis of the ring in all cases but those in which it is expressly stated otherwise.

Reducing these distances to the mean distance of *Saturn*, of which the logarithm is 0.97968, and to the center of the ball by using for the equatorial diameter 18″.0 and for the diameter of the ring 40″.09; also reducing the times to decimals of a day, and correcting for aberration; we have the following results: —

Enceladus.

Time Corrected for Aberration.		Satellite preceding or following Saturn's center.		Weight = W.
1848, Oct.	5.3112	31″.51	E. follows ♄	W. = 3
	5.3863	32.82	“	= 2
	7.3140	32.72	E. precedes ♄	= 2
	9.2632	24.80	E. follows ♄	W. = 2
1848, Oct.	12.2832	30″.94	E. follows ♄	W. = 3
	20.3113	32.85	“	= 2
	23.3089	25.47	“	= 2
	*30.0542	32.04	“	= 2
	30.2306	20.04	“	= ¼
Nov.	2.2555	24.47	E. precedes ♄	= 2
	3.3046	20.13	E. follows ♄	= 2
1849, Jan.	12.2520	16.63	E. precedes ♄	= 0
1852, Jan.	24.2869	31.00	E. follows ♄	= ¼
	26.1977	30.03	E. precedes ♄	= 2
	26.2171	29.46	“	= 2
	26.2949	32.63	“	= 1
Feb.	2.2033	34.03	“	= 2
	2.2666	31.73	“	= 2
	3.3310	20.04	“	= 1
	4.2178	33.03	E. follows ♄	= 1
	7.2057	15.03	“	= 3
	17.2354	34.86	E. precedes ♄	W. = 3

Tethys.

1852, Jan.	27.2393	10″.89	T. follows ♄	W. = 3
	29.2107	0.00	T. in conj. with ♄	= 4
	29.3440	17.45	T. precedes ♄	= 2
Feb.	2.2124	29.33	“	= 2
	2.2610	33.65	“	= 2
	2.3554	41.35	“	= 2
	3.2192	34.11	T. follows ♄	= 2
	3.3373	40.78	“	= 2
	3.2241	6.07	T. above axis	
	3.3282	3.01	“	
	4.2275	38.80	T. precedes ♄	= 1
	5.2525	41.69	T. follows ♄	= 1
	7.2127	42.86	“	= 1.5
	14.2322	5.46	T. precedes ♄	= 2
	16.2376	11.20	T. follows ♄	W. = 2

To obtain the mean distances and epochs from the foregoing observations, the mode of calculation has been as follows: —

The angle between the radius-vector R of the satellite and the line joining *Saturn's* center with the projection of the earth's place upon the plane of the ring being represented by φ, $R \sin \varphi$ will be the distance of the satellite from the planet measured in the direction of the major axis of the ring, and is the quantity given by the above observations. The inclination of the orbits to the ring is nearly if not quite insensible. If the orbit is circular, φ will be obtained from the mean motion and an assumed epoch of conjunction by applying a correction for the motion of the earth and *Saturn*.

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* The observations for November 30th were made by Rev. W. R. Dawes, and are taken from the *Monthly Notices of the Astronomical Society, for January*, 1850. A small weight is given to the second observation, the distance having been estimated by the eye.

For this correction the following table has been used, computed from the values of the node and inclination of the ring for 1850.0. ☊ $= 167° 32'$, $i = 28° 10$, upon the ecliptic; or, referred to the equator, $N = 125° 01$, $t = 7° 10'$; l represents the elevation of the earth seen from *Saturn* above the north side of the ring, and λ the angular distance of the earth seen from *Saturn* counted on the plane of the ring from the ascending node in 1850 upon the equator. The last column contains the corrections to be applied to the times of observation, to reduce them for the time of passage of light to the earth.

Date.	l	λ	Correction for Aberration. d.
1848, Sept. 29	+0° 35′	47° 10′	—0.0497
Oct. 4	0 45	47 21	.0498
9	0 54	47 03	.0500
14	1 03	46 47	.0502
19	1 10	46 32	.0505
24	1 15	46 19	.0508
29	1 20	46 07	.0512
Nov. 3	1 23	45 57	.0516
1849, Jan. 12	+0 19	47 27	.0578
Oct. 27	—4 39	57 52	.0496
1852, Jan. 13	15 23	81 12	.0521
18	15 28	81 21	.0529
23	15 33	81 32	.0533
28	15 40	81 45	.0538
Feb. 2	15 48	82 01	.0543
7	15 57	82 19	.0547
12	16 06	82 39	.0551
17	16 15	83 02	.0556
22	—16 25	83 27	—0.0561

The difference of the values of λ on different dates will be the correction to be applied to the angular motion of each satellite from one epoch to another to reduce it to the actual line of conjunction with the earth.

A comparison of the observations for 1848 with those of 1852 gave for the time of revolution of *Enceladus*

$$T = 1^{\mathrm{d}}.3702167.$$

For *Tethys* I have used the value $T = 1^{\mathrm{d}}.8877974$, derived from Sir John Herschel's mean daily motion. That given by Lamont (*Astr. Nach.* Vol. XIV. No. 321) is nearly the same; Herschel's mean daily motion being 190°.6984, Lamont's 190°.6981. The time of revolution of *Enceladus* given by Madler (*Populäre Astron.*, p. 263, ed. for 1850) would accord better with the above by supposing the assumed number of entire revolutions between 1789 and 1836 to have been one too large, for which supposition he has given the proper correction. The interval in days between the successive returns of the two satellites to the same point in their orbits is subjoined.

Enceladus.		*Tethys.*	
No. of entire Revolutions.	Interval in Days. d.	No. of entire Revolutions.	Interval in Days. d.
1	1.3702	1	1.8878
2	2.7404	2	3.7756
3	4.1106	3	5.6634
4	5.4809	4	7.5512
5	6.8511	5	9.4390
6	8.2213	6	11.3268
7	9.5915	7	13.2146
8	10.9617	8	15.1024
9	12.3320	9	16.9902
10	13.7022	10	18.8780
11	15.0724	11	20.7658
12	16.4426	12	22.6536
13	17.8128	13	24.5414
14	19.1830	14	26.4292
15	20.5532	15	28.3170
16	21.9235	16	30.2048
17	23.2937		
18	24.6639		
19	26.0341		
20	27.4043		
21	28.7746		
22	30.1448		

An approximate solution with circular elements for *Enceladus* made $R = 34''.0$, and for the epochs of conjunction with the earth, November 3.4492, 1848, and February 7.3057, 1852. Equations of condition were then formed for $\delta\varphi$ and δR, the corrections of φ and R from the expression

$$\sin\varphi \,.\, \delta R + R \cos\varphi \,.\, \delta\varphi = \text{observed distance} - \text{comp. dist.}$$

as follows: —

		Nos. used for W. × coef. δR	Nos. used for W. × coef. $\delta\varphi$
1848, Oct. 5	$1.00\,\delta R + 1\,\delta\varphi = +0''.5$	3	0.3
5	$0.97\,\delta R + 7\,\delta\varphi = -0.3$	2	1
7	$0.94\,\delta R - 12\,\delta\varphi = +0.9$	2	—2.5
9	$0.67\,\delta R - 25\,\delta\varphi = +2.2$	1.33	—5
12	$0.90\,\delta R + 14\,\delta\varphi = +0.1$	2.5	4
20	$0.91\,\delta R - 14\,\delta\varphi = +2.0$	2	—3
23	$0.73\,\delta R + 23\,\delta\varphi = +0.5$	1.5	5
30	$0.97\,\delta R + 9\,\delta\varphi = -0.8$	1	1
30	$0.47\,\delta R + 30\,\delta\varphi = +3.7$	0.12	0.7
Nov. 2	$0.73\,\delta R - 23\,\delta\varphi = -0.1$	1.5	—5
3	$0.62\,\delta R + 27\,\delta\varphi = -0.5$	1.5	5
1852, Jan. 21	$0.99\,\delta R + 5\,\delta\varphi = -2.7$	0	0
26	$0.86\,\delta R - 17\,\delta\varphi = +0.8$	2	3
26	$0.91\,\delta R - 15\,\delta\varphi = -1.2$	2	3
26	$1.00\,\delta R - 3\,\delta\varphi = -1.3$	1	1
Feb. 2	$0.98\,\delta R + 6\,\delta\varphi = +0.5$	2	1
2	$0.90\,\delta R + 15\,\delta\varphi = +1.2$	2	3
3	$0.59\,\delta R - 28\,\delta\varphi = 0.0$	1	3
4	$1.00\,\delta R - 1\,\delta\varphi = -1.0$	1	0
7	$0.41\,\delta R + 31\,\delta\varphi = -0.2$	1	9
17	$1.00\,\delta R + 1\,\delta\varphi = +0.9$	3	0

From the solution of the equations for 1848 by the method of least squares, using the numbers above given for $W \times$ coef. δR and $W \times$ coef. $\delta \varphi$, we obtain,

$$\delta R = +0''.62 ; \ \delta \varphi = -1^\circ.5.$$

$$\text{Correction of epoch} = -\frac{1^\circ.5}{263^\circ.73} = -0^{\mathrm{d}}.0057.$$

A similar process gives for 1852,

$$\delta R = +0''.23 \text{ and } \delta \varphi = +0^\circ.55.$$

$$\text{Correction of epoch} = +\frac{0^\circ.55}{272^\circ.73} = +0^{\mathrm{d}}.0021.$$

The corrected values are therefore,

for 1848, $R = 34''.62$; epoch of conjunction Nov. 3.4435.
for 1852, $R = 34''.23$; epoch of conjunction Feb. 7.3078.

Comparison of New Values of R and φ with Observation.

1848.	Obs. — Comp.	W × coef. δ R.	1852.	Obs. — Comp.	W × coef. δ R.
Oct. 5	—0″.1	3	Jan. 24	—3″.0	0
5	—0.9	2	26	+0.7	2
7	0.0	2	26	—1.2	2
9	+1.1	1.33	26	—1.3	1
12	—0.1	2.5	Feb. 2	+0.2	2
20	+1.1	2	2	+0.8	2
23	+0.6	1.5	3	+0.1	1
30	—1.2	1	4	—1.2	1
30	+4.2	0.12	7	—0.6	1
Nov. 2	—1.2	1.5	17	+0.7	3
3	—0.2	1.5			

Excepting the differences on November 30th, 1848, second observation, and January 24th, 1852, which are entitled to but very small weight, being only estimates by the eye, there appears to be no sufficient deviation from a circular orbit to found a determination of the eccentricity upon. In the course of two or three years the plane of the orbit will be better presented for ascertaining this element. The mean of the results for R in 1848 and 1852, viz. 34″.4, is adopted as the true mean distance of *Enceladus* at the mean distance of *Saturn*, of which the logarithm is 0.97968.

In 1848 all but two of the measurements of *Enceladus* were made when it was on the *following* side of the planet; the mean of these, having regard to their proper weights, gives a distance, $R = 34''.68$.

In 1852 all but three of the observations were on the *preceding* side, giving $R = 34''.38$. The difference may perhaps be ascribed to an eccentricity.

The following are the results of a similar discussion of the observations upon *Tethys*. Assuming as a first approximation, $R = 42''.0$, epoch of conjunction, January 29.2107, 1852.

Equations for Tethys.

1852.		Nos. used for W × coef. δ R	Nos. used for W × coef. δ φ
Jan. 27	$0.27\,\delta R - 40\,\delta\varphi = -0''.6$	0.8	—1.2
29	$0.00\,\delta R + 42\,\delta\varphi = 0.0$	0.0	+1.7
29	$0.42\,\delta R + 38\,\delta\varphi = -0.5$	0.8	0.8
Feb. 2	$0.68\,\delta R + 31\,\delta\varphi = +0.7$	1.4	0.6
2	$0.79\,\delta R + 26\,\delta\varphi = +0.3$	1.6	0.5
2	$0.94\,\delta R + 14\,\delta\varphi = +0.8$	1.9	0.3
3	$0.82\,\delta R + 24\,\delta\varphi = -0.2$	1.6	0.5
3	$0.97\,\delta R + 9\,\delta\varphi = -0.2$	2.0	0.2
4	$0.92\,\delta R + 16\,\delta\varphi = +0.1$	0.9	0.2
5	$0.99\,\delta R + 5\,\delta\varphi = 0.0$	1.0	+0.1
7	$1.00\,\delta R - 5\,\delta\varphi = +1.1$	1.5	—0.1
14	$0.10\,\delta R + 42\,\delta\varphi = +1.3$	0.2	+0.8
16	$0.28\,\delta R + 40\,\delta\varphi = -0.7$	0.6	0.8

From the solution of which we obtain,

$$\delta R = +0''.22 ; \ \delta \varphi = +0^\circ.15.$$

$$\text{Correction of epoch} = \frac{0^\circ.15}{190^\circ.69} = +0^{\mathrm{d}}.0008.$$

The corrected values are therefore for *Tethys*, $R = 42''.22$, and epoch of conjunction, 1852, Jan.$29^{\mathrm{d}}.2099$.

Comparison of New Values of R and φ with Observation.

	Obs. — Comp.	W × coef. δ R.
1852, Jan. 27	—0.5	0.8
29	—0.1	0.0
29	—0.7	0.8
Feb. 2	+0.5	1.4
2	+0.1	1.6
2	+0.6	1.9
3	—0.4	1.6
3	—0.4	2.0
4	—0.1	0.9
5	—0.2	1.0
7	+0.9	1.5
14	+1.2	0.2
16	—0.9	0.6

From some observations of *Mimas* in 1848 the following results have been obtained.

Epoch of conjunction with the earth, 1848, Oct. 5.2029.
Mean distance, ... 27″.4.

The times of conjunction are corrected for aberration.

Cambridge, 1852, *March 2d.*

NEW WORKS.

De Sterrekundige Plaotsbepaling in den Indischen Archipel, door F. KAISER, *Hoogleeraar te Leiden.* Amsterdam, 1851. The government of Holland have recently, at the instance of Professor KAISER of the Leyden Observatory, organized a scientific expedition for making astronomical determinations of the position of the chief points in the Asiatic colonies of Holland. An astronomical party has now been sent to Java with a full supply of instruments of the first order, — and placed under the able direction of the accomplished chief of the Leyden Observatory. In the present work, Professor KAISER describes the measures taken, and the plans adopted, together with the principles which ought in his opinion to govern an expedition of this character.

Eene Nieuwe Toepassing van het Beginsel der Noniën op den Tijd voor het Waarnemen van Plotselijke Verschijnselen, door F. KAISER. This memoir, reprinted from the Journal of the Royal Institute of the Netherlands, 1851 (*Deel* V., *Bladzijde* 9), contains a discussion of the application of the principle of the Nonius to the determination or measurement of time. After an historical sketch of the recent advances, especially by the application of the telegraph, the author proposes a method of obtaining the same result as with the circuit-breaking clock.

Lehrbuch der Sphärischen Astronomie von Dr. F. BRÜNNOW. Berlin, 1851. The want of a proper text-book to be placed in the hands of students of Astronomy has become a reproach to the science. Dr. BRÜNNOW, lately Director of the Observatory at Bilk, and now attached to that of Berlin, has endeavored to remove this reproach, by the preparation of the *Lehrbuch der Sphärischen Astronomie*, in which all the chief problems of this branch of our science are treated in a masterly manner. Those who are acquainted with the author through his essays in the last volumes of the *Astronomische Nachrichten*, can appreciate his qualifications for such a work as this. He has availed himself freely of the labors of the great masters, particularly GAUSS and BESSEL, and the student will find here, collected in one volume, all the formulas and methods now in every-day use among practical astronomers for the computation of precession, nutation, aberration, parallax, for the determination of geographical positions, for the adjustment and use of instruments, &c.

It is earnestly to be hoped that this valuable work may be translated into the English tongue, and all true astronomers will share the earnest wish, if not the confidence, expressed by ENCKE in his Preface to the work: "I shall regard it as a most favorable indication of the scientific tendency in our country, if, beside the numerous popular works on astronomy, this book, demanding as it does a more earnest interest in the science, shall meet with such a reception as may encourage the author cheerfully to continue upon the path on which he has entered."

The work is published by DÜMMLER of Berlin, and may be obtained of most of the importing booksellers in this country.

G.

KESSELS CLOCK.

AN excellent astronomical clock, from the master hand of KESSELS and nearly new, is offered for sale at a price much less than its real value. The late Professor SCHUMACHER bore testimony to its admirable character, and at his request the Editor of this Journal has taken charge of the clock until it shall be disposed of. He will be happy to give farther information if desired.

G.

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NOTE UPON THE CONICAL PENDULUM.

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PERKINS PROFESSOR OF ASTRONOMY AND MATHEMATICS IN HARVARD UNIVERSITY.

1. THE following application of LAGRANGE's method of the variation of arbitrary constants to the motion of the Conical Pendulum, may not be regarded as uninstructive and unworthy of the *Astronomical Journal.* The equations given by LAPLACE, [69, 70, and 72] of BOWDITCH's translation, changing for convenience 2λ into λ^2, and using v for the velocity, are

$$D^2 x + \lambda^2 x = 0,$$
$$D^2 y + \lambda^2 y = 0,$$
$$\lambda^2 = \frac{c+3gz}{r^2} = \frac{c+3g\sqrt{(r^2-x^2-y^2)}}{r^2} = \frac{v^2+gz}{r^2}.$$

2. In a first approximation, λ may be regarded as constant, which gives

$$x = A\cos(\lambda t + \varepsilon),$$
$$y = A'\cos(\lambda t + \varepsilon');$$

in which A, A', ε and ε' are arbitrary constants. In this approximation, therefore, the horizontal motion is elliptical, the center of the ellipse is directly beneath the point of suspension, and the angle which is known in astronomy as the *eccentric anomaly* is described uniformly. Another pair of rectangular axes of X and Y, of which the former is directed in the major axis of the ellipse, and which makes an angle θ with the axis of x, may be conveniently introduced. If the major and minor axes of the ellipse are respectively denoted by a and b, and if ε is assumed to be the value of the eccentric anomaly at the origin of the time, the equations are easily obtained.

$$x = X\cos\theta - Y\sin\theta,$$
$$y = X\sin\theta + Y\cos\theta,$$
$$X = a\cos(\lambda t + \varepsilon),$$
$$Y = b\sin(\lambda t + \varepsilon);$$
$$X' = DX = -a\lambda\sin(\lambda t + \varepsilon) = -\frac{a}{b}\lambda Y,$$
$$Y' = DY = b\lambda\cos(\lambda t + \varepsilon) = \frac{b}{a}\lambda X,$$
$$x' = Dx = X'\cos\theta - Y'\sin\theta,$$
$$y' = Dy = X'\sin\theta + Y'\cos\theta,$$
$$z^2 = r^2 - X^2 - Y^2 = r^2 - a^2\cos^2(\lambda t + \varepsilon) - b^2\sin^2(\lambda t + \varepsilon)$$
$$= r^2 - \tfrac{1}{2}(a^2+b^2) - \tfrac{1}{2}(a^2-b^2)\cos 2(\lambda t + \varepsilon),$$
$$v^2 = DX^2 + DY^2 = \tfrac{1}{2}(a^2+b^2)\lambda^2 - \tfrac{1}{2}(a^2-b^2)\lambda^2\cos 2(\lambda t + \varepsilon).$$

3. The substitution of

$$\tan^4\tfrac{1}{2}\beta = \frac{r^2-a^2}{r^2-b^2},$$
$$M^2 = \tfrac{1}{4}(a^2-b^2)\sec\beta,$$
$$\alpha = \cos\beta,$$

gives

$$a^2 - b^2 = 4M^2\cos\beta = 4M^2\alpha,$$
$$1 - \tan^4\tfrac{1}{2}\beta = \frac{a^2-b^2}{r^2-b^2} = \cos\beta\sec^4\tfrac{1}{2}\beta = \frac{4M^2\cos\beta}{r^2-b^2},$$
$$r^2 - b^2 = 4M^2\cos^4\tfrac{1}{2}\beta = M^2(1+\cos\beta)^2 = M^2(1+\alpha)^2,$$
$$r^2 - a^2 = 4M^2\sin^4\tfrac{1}{2}\beta = M^2(1-\cos\beta)^2 = M^2(1-\alpha)^2,$$
$$2r^2 - (a^2+b^2) = 2M^2(1+\alpha^2);$$
$$z^2 = M^2[1+\alpha^2 - 2\alpha\cos 2(\lambda t + \varepsilon)].$$

Hence the formula for planetary perturbations, [964] of BOWDITCH's Translation of LAPLACE, gives

$$z = \tfrac{1}{2}M\Sigma_{-\infty}^{+\infty}\, b_{-\frac{1}{2}}^{i}\cos 2i(\lambda t + \varepsilon).$$

The value of v^2,

$$v^2 = -\lambda^2 M^2(1+\alpha^2) + r^2\lambda^2 - 2M^2\alpha\lambda^2\cos 2(\lambda t + \varepsilon),$$

substituted in that of λ^2, gives by transposition and division by M,

$$M\lambda^2[(1+\alpha^2) + 2\alpha\cos 2(\lambda t + \varepsilon)] = \tfrac{1}{2}g\Sigma_{-\infty}^{+\infty}\, b_{-\frac{1}{2}}^{i}\cos 2i(\lambda t + \varepsilon);$$

from which λ^2 can be determined in various ways in the form

$$\lambda^2 = \Sigma_{-\infty}^{+\infty}\,\lambda_i^2\cos 2i(\lambda t + \varepsilon).$$

The constant part of $\lambda = \lambda_0$, gives the value of λ which is to be used in a first approximation.

The successive terms of λ^2 are connected by the equation

$$\lambda_i^2(1+\alpha^2) + 2\alpha\lambda_{i-1}^2 = \tfrac{1}{2}g\, b_{-\frac{1}{2}}^{(i-1)}.$$

4. In the case of exact circular motion, the equations are,

$$a = b,$$
$$M^2 = r^2 - a^2,$$
$$z = \sqrt{(r^2-a^2)},$$
$$\lambda^2 = \frac{g}{M} = \frac{g}{z} = \frac{g}{\sqrt{(r^2-a^2)}}.$$

5. In case α is so small that its first power only need be retained, the equations become,

$$M \lambda^2 [1 + 2 \alpha \cos 2 (\lambda t + \varepsilon)] = g [1 - \alpha \cos 2 (\lambda t + \varepsilon)],$$

$$\lambda^2 = \frac{g}{M} [1 - 3 \alpha \cos 2 (\lambda t + \varepsilon)],$$

$$M^2 = r^2 - \tfrac{1}{2} (a^2 + b^2).$$

6. In order to obtain the second approximation, account must be taken of the variability of the elliptic elements, which arises from the change of λ. This may be done by regarding $(\lambda^2 - \lambda_0^2) r$ as a disturbing force, which acts in the direction of the pendulum-rod, and computing its effect by LAGRANGE's method. The notation of the *Mécanique Analytique* gives

$$D_a x = \cos \theta \;\; D_a X - \sin \theta \;\; D_a Y,$$
$$D_a x' = \cos \theta \;\; D_a X' - \sin \theta \;\; D_a Y',$$
$$\text{\&c.} \qquad \text{\&c.} \qquad \text{\&c.};$$

$$D_a X = \frac{X}{a}, \qquad D_a Y = 0,$$

$$D_a X' = -\frac{\lambda}{b} Y, \qquad D_a Y' = 0,$$

$$D_b X = 0, \qquad D_b Y = \frac{Y}{b},$$

$$D_b X' = 0, \qquad D_b Y' = \frac{\lambda}{a} X,$$

$$D_\varepsilon X = -\frac{a}{b} Y, \qquad D_\varepsilon Y = \frac{b}{a} X,$$

$$D_\varepsilon X' = -\lambda X, \qquad D_\varepsilon Y' = -\lambda Y;$$

$$[a, b] = \quad D_a X\, D_b X' + D_a Y\, D_b Y' - D_a X'\, D_b X$$
$$- D_a Y'\, D_b\, Y = 0,$$

$$[a, \varepsilon] = -\lambda \frac{X^2}{a} - \frac{a}{b^2} \lambda Y^2 = -\lambda_0 a,$$

$$[b, \varepsilon] = -\frac{\lambda}{b} Y^2 - \frac{b}{a^2} \lambda X^2 = -\lambda_0 b,$$

$$D_\theta x = -\sin \theta X - \cos \theta Y,$$
$$\text{\&c.} \qquad \text{\&c.}$$

$$[a, \theta] = X' D_a Y - X D_a Y' - Y' D_a X + Y D_a X',$$
$$= D_a (X' Y - Y' X) = - D_a (\lambda a b) = -\lambda_0 b,$$

$$[b, \theta] = -\lambda_0 a,$$

$$[\varepsilon, \theta] = \quad 0.$$

7. The vertical portion of the disturbing force of the ellipse is only indirectly effective through the value of λ, and the horizontal portion, which acts directly, becomes by putting

$$\varrho^2 = r^2 - x^2,$$

$$\text{Disturbing force} = (\lambda^2 - \lambda_0^2)\, \varrho.$$

Hence, LAGRANGE's notation gives

$$D_\varrho \Omega = -(\lambda^2 - \lambda_0^2)\, \varrho,$$

$$-\lambda_0 a D_t \delta \varepsilon - \lambda_0 b D_t \delta \theta = \quad D_a \Omega = -(\lambda^2 - \lambda_0^2)\, \varrho D_a \varrho = -\tfrac{1}{2} (\lambda^2 - \lambda_0^2) D_a \varrho^2$$
$$= -\tfrac{1}{2} (\lambda^2 - \lambda_0^2) D_a [(a^2 + b^2) + (a^2 - b^2) \cos 2 (\lambda t + \varepsilon)]$$
$$= -\tfrac{1}{2} (\lambda^2 - \lambda_0^2) [a + a \cos 2 (\lambda t + \varepsilon)]$$

$$-\lambda_0 b D_t \delta \varepsilon - \lambda_0 a D_t \delta \theta = -\tfrac{1}{2} (\lambda^2 - \lambda_0^2) [b - b \cos 2 (\lambda t + \varepsilon)]$$

$$\lambda_0 a D_t \delta a + \lambda_0 b D_t \delta b = \quad \tfrac{1}{2} (\lambda^2 - \lambda_0^2) (a^2 - b^2) \sin 2 (\lambda t + \varepsilon)$$

$$\lambda_0 b D_t \delta a + \lambda_0 a D_t \delta b = 0.$$

8. The last of these equations shows that the area of the ellipse is invariable, which might have been anticipated. We have then by integration

$$\lambda_0 \delta (a^2 + b^2) = \int (\lambda^2 - \lambda_0^2) (a^2 - b^2) \sin 2 (\lambda t + \varepsilon),$$

$$\lambda_0 \delta \varepsilon = \tfrac{1}{2} \int (\lambda^2 - \lambda_0^2) [1 + \frac{a^2 + b^2}{a^2 - b^2} \cos 2 (\lambda t + \varepsilon)],$$

$$\lambda_0 \delta \theta = -\frac{a b}{a^2 - b^2} \int (\lambda^2 - \lambda_0^2) \cos 2 (\lambda t + \varepsilon).$$

9. From these equations, it is evident that the values of $\delta \varepsilon$ and $\delta \theta$ consist of secular terms proportional to the time, and of periodic terms of which the period is the same with that of the complete vibration of the pendulum, or an aliquot part of it; while δa and δb consist only of such periodic terms without any secular term.

10. When α is so small that all its powers but the first may be neglected, we have for the secular terms,

$$\lambda^2 - \lambda_0^2 = -3 \alpha \frac{g}{M} \cos 2 (\lambda_0 t + \varepsilon) = -3 \alpha \lambda_0^2 \cos 2 (\lambda_0 t + \varepsilon),$$

$$\delta \varepsilon = -\tfrac{3}{4} \frac{a^2 + b^2}{a^2 - b^2} \alpha \lambda_0 t = -\tfrac{3}{16} \frac{a^2 + b^2}{M^2} \lambda_0 t,$$

$$\delta \theta = \quad \tfrac{3}{2} \frac{a b.}{a^2 - b^2} \alpha \lambda_0 t = \quad \tfrac{3}{8} \frac{a b}{M^2} \lambda_0 t.$$

This value of $\delta \theta$ agrees precisely with that which AIRY has given for the motion of the line of apsides in Vol. XX. of the Memoirs of the Royal Astronomical Society, and which he has investigated by a more restricted process. There is substantially the same agreement in regard to the value of $\delta \varepsilon$, which is properly to be combined with $\lambda_0 t$, and arises partly from the motion of the apsides, and partly from the difference between the area of the ellipse of which the axes are $2a$ and $2b$, and the oval actually described. The results of this solution coincide also with those given by LAGRANGE in the second volume of the *Mécanique Analytique*.

11. It might be inquired whether there is any sensible mechanical effect arising from the earth's rotation, in addition to the apparent and geometrical phenomenon, which is exhibited in FOUCAULT's experiment. But when it is considered, that, in

the motion of the point of suspension, the constant part of the velocity can have no effect, and the constant part of the first differential coefficient of the velocity is confounded with gravitation, it must appear that the residual effect is of a minute order. I have found, indeed, by an exact computation, which is not of sufficient interest for publication, that the order of this disturbance is the same with that of the earth's rotation compared with the mean motion of the pendulum. The principal portion of the perturbation may be computed by adding to the first members of the first equations [69] of LAPLACE

$$-2\,n \cos l \sin n'\,t\,.\,\frac{x}{\varrho}\,D\,x - (D\,x \sin n'\,t + D\,y \cos n\ \,t)\,\frac{2\,n\,x \cos l}{\surd(R^2-\varrho^2)}\,,$$
$$-2\,n \cos l \cos n'\,t\,.\,\frac{y}{\varrho}\,D\,y - (D\,x \sin n'\,t + D\,y \cos n'\,t)\,\frac{2\,n\,y \cos l}{\surd(r^2-\varrho^2)}\,;$$

in which n is the earth's mean motion of rotation, l the latitude,

$$n' = n \sin l\,,$$

and the axes of x and y are supposed to be freed from the earth's rotation about the vertical axis, so as to keep pace with the apparently rotating line of apsides of the pendulum, so far as this motion depends upon the earth's rotation, and the axis of x is supposed to be in the meridian at the origin of the motion.

12. The effect of the resistance of the still atmosphere, which is proportional to the square of the velocity, may be found in the case of a symmetrical pendulum, if h denotes the coefficient of this resistance, from the equations

$$(a^2-b^2)\,D_t\,\delta\,\varepsilon = -\tfrac{1}{2}\,(a^2+b^2)\,h\,v \sin 2\,(\lambda\,t+\varepsilon)\,,$$
$$(a^2-b^2)\,D_t\,\delta\,\theta = \quad a\,b\,h\,v \sin 2\,(\lambda\,t+\varepsilon)\,,$$
$$(a^2-b^2)\,D_t\,\delta\,a = -\left(\frac{v^2}{\lambda^2}-b^2\right)h\,a\,v = -\tfrac{1}{2}\,(a^2-b^2)\,h\,a\,v\,[1-\cos 2\,(\lambda\,t+\varepsilon)]\,,$$
$$(a^2-b^2)\,D_t\,\delta\,b = -\left(a^2-\frac{v^2}{\lambda^2}\right)h\,b\,v = -\tfrac{1}{2}\,(a^2-b^2)\,h\,b\,v\,[1-\cos 2\,(\lambda\,t+\varepsilon)]\,,$$
$$D_t\,\delta \log a = D_t\,\delta \log b = -\tfrac{1}{2}\,h\,v\,[1-\cos 2\,(\lambda\,t+\varepsilon)]\,.$$

There is, therefore, no secular change of the first order of the disturbing force in the values of ε and θ, and during the continual diminution of a and b their ratio remains unchanged. These equations give

$$D_t\,\delta\,.\,a^{-1} = -a^{-2}\,D_t\,\delta\,a = \tfrac{1}{2}\,h\,\frac{v}{a}\,[1-\cos 2\,(\lambda\,t+\varepsilon)]\,,$$

in which the second member is a function of $\frac{a}{b}$ and t, and the part which is not periodic is absolutely constant. The secular increments of a^{-1} and b^{-1} are, then, proportional to the time so far as they depend upon this form of atmospheric resistance.

13. If the resistance is supposed proportional to the velocity, which AIRY regards as the more accurate law at these small velocities, the second members of the equations of the preceding section should be divided by v, and in this case we should have

$$D_t\,\delta\,.\log a = D_t\,\delta\,.\log b = -\tfrac{1}{2}\,h\,[1-\cos 2\,(\lambda\,t+\varepsilon)]$$

in which the secular portion is constant. The secular increments of $\log a$ and $\log b$ are, then, in this case, proportional to the time. The comparison of the results of this section with those of the preceding one suggests an obvious method of determining by experiment the true law of atmospheric resistance.

14. The resistance of the still atmosphere upon an unsymmetric pendulum may, in a large class of cases, be analyzed with sufficient accuracy into two portions, of which one is directly opposed to the motion of the pendulum, and the other is always directed in a given fixed azimuth, which may be assumed to be that of the axis of x. The effect of the former portion is computed by the method of the preceding sections, but that of the second portion may be found, if we denote by h' the coefficient of this portion of the resistance, which we may suppose to be proportional to the nth power of the velocity x' in the direction of x, from the equations

$$(a^2-b^2)\,\lambda\,D_t\,\delta\,\varepsilon = \pm\,h'\,x'^n\,[a \cos\theta \cos(\lambda\,t+\varepsilon) + b \sin\theta \sin(\lambda\,t+\varepsilon)]$$
$$(a^2-b^2)\,\lambda\,D_t\,\delta\,\theta = \mp\,h'\,x'^n\,[a \sin\theta \sin(\lambda\,t+\varepsilon) + b \cos\theta \cos(\lambda\,t+\varepsilon)]$$
$$\lambda\,D_t\,\delta\,a = \pm\,h'\,x'^n \cos\theta \sin(\lambda\,t+\varepsilon)$$
$$\lambda\,D_t\,\delta\,b = \pm\,h'\,x'^n \sin\theta \cos(\lambda\,t+\varepsilon)\,.$$

The upper sign is to be used in these equations when n' is an odd number, and when n' is even and x' positive, but the lower sign is to be used when n' is even and x' negative.

15. In case we make n equal to unity, the preceding equations give for the secular changes of the elements

$$D_t\,\delta\,\varepsilon = \tfrac{1}{2}\,h'\,\frac{a\,b}{a^2-b^2} \sin 2\,\theta\,,$$

$$D_t\,\delta\,\theta = \tfrac{1}{4}\,h'\,\frac{a^2+b^2}{a^2-b^2} \sin 2\,\theta\,,$$
$$D_t\,\delta\,a = -\tfrac{1}{2}\,h'\,a \cos^2\theta\,,$$
$$D_t\,\delta\,b = -\tfrac{1}{2}\,h'\,b \sin^2\theta\,;$$

whence,

$$D_t\,(\log a) = -\tfrac{1}{2}\,h' \cos^2\theta\,,$$
$$D_t\,(\log b) = -\tfrac{1}{2}\,h' \sin^2\theta\,.$$

16. In case n' is zero, which corresponds approximately to a constant current of air blowing in the direction of the axis of x, we find by supposing x' to be zero, at the origin of the time,

$$\begin{aligned}
(a^2 - b^2)\,\lambda^2\,D_t\,\delta\,\varepsilon &= -2\,h'\,(a\cos\theta\sin\varepsilon + b\sin\theta\cos\varepsilon) = -4\,h'\,a\cos\theta\sin\varepsilon \\
(a^2 - b^2)\,\lambda^2\,D_t\,\delta\,\theta &= 2\,h'\,(a^2 + b^2)\sin\theta\cos\varepsilon \\
\lambda^2\,D_t\,\delta\,a &= 2\,h'\cos\theta\cos\varepsilon \\
\lambda^2\,D_t\,\delta\,b &= -2\,h'\sin\theta\sin\varepsilon \\
a\tan\varepsilon + b\tan\theta &= 0.
\end{aligned}$$

17. The effect of the rotation of the pendulum about its axis deserves to be investigated, but the mode of research should be of quite a different kind, and is, therefore, deferred to another communication.

ON THE ORIGIN OF THE FORMS AND THE PRESENT CONDITION OF SOME OF THE CLUSTERS OF STARS AND SEVERAL OF THE NEBULÆ.

By STEPHEN ALEXANDER,
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(*Continued from page* 128.)

Both nebulæ, moreover, exhibit traces of an *outward* dispersion of material quite consistent with the hypothesis of an equilibrium destroyed; which dispersion seems now to have advanced as far as that contemplated in the hypothetical case represented in *Fig*. 25, or rather to have advanced so far *a few centuries ago;* viz. about the time when the light, which recently met the observers' eyes, left the region where the nebula is situated.*

The more distinct features of the great nebula about θ *Orionis*, H. 360, are not unlike those of the nebula (or two nebulæ) last described. Sir John Herschel, in his description of the form of *Fig*. 26, compares it to that of a Greek Ω, and remarks that it is "not unlike the nebula in *Orion*" "as it used to be figured." In Mr. W. C. Bond's very beautiful representation of that nebula, as seen with the great refractor at Cambridge (*Memoirs of the American Academy of Arts and Sciences*, New Series, Vol. III. Plate at p. 96), the principal features of *Fig*. 26 are visible amidst the more dense portions. Every thing indicates the mass to be very great; and, admitting its annular origin, the preëxisting ring would seem itself to have been very broad; and the nebulous group or knot (derived from the folding of the ring), to be nearer to us than many other portions of the nebula. There is, again, much dispersed material in the same region, and an appendage like that in *Fig*. 6.

Fig. 28 is copied from that of Sir John Herschel (*Results of Observations, &c. at the Cape*, Plate III. Fig. 6); and represents H. 2806 to 2810 inclusive. Its features are very similar to those represented in *Fig*. 26 or *Fig*. 27; with some traces of the ring having been condensed in more places than one; or of appendages having been developed, similar to that seen in *Fig*. 6, and heretofore specially noticed.

H. 2092, figured by Sir John Herschel (*Phil. Trans. for* 1833, Plate XI. Fig. 31), looks like a nebula of this same order, somewhat bent out of its original plane and seen very much sidewise; and H. 2088 (Fig. 33, same Plate) may possibly be of a similar form seen very much endwise.

H. 2315 (*Results of Observations, &c. at the Cape*, Plate IV. Fig. 8) may, again, by possibility, be such a nebula seen still more completely endwise.

Other traces of broken rings may perhaps be found in complex nebulæ, of which more hereafter; but the rare occurrence of forms of this class, both annular and convoluted, is itself a fact not out of place, upon the hypothesis of their annular (or ultimately spheroidal) origin; as the circumstances must have been extraordinary which permitted the equatorial ring to acquire a sufficient preponderance.

Class IV.

(*Primitive Form a decidedly oblate Ellipsoid?*)

That the form here designated presents a supposable case of equilibrium of a rotating mass, when the three axes are unequal, is especially shown in Mr. Ivory's paper (*Phil. Trans. for* 1838, p. 57).

During the process of cooling of such a mass, it would seem that there might be a tendency to two centers of condensation in the line of the longest axis; and, as a consequence, two separate rotations, in the same general direction, around those centers; in accordance with the general principles discussed in the introduction to Class I., and at the outset.* As a further consequence, the phenomena exhibited by the spirals (Class I. Order 1st) might also find place in the results of accelerated rotation around each center. Something like this arrangement, and sometimes its effects, would seem to be still indicated in some few instances of —

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* The primary rings may have formed a binary system, as may still be true of the nebulæ resulting from them; of which more hereafter.

"*Binuclear*" *Nebulæ with some Symmetry of Outline.*

In *Fig.* 8, two nuclei are very conspicuous, with spirals or curved branches thrown off from them. A star or condensation also still exists, to mark, as it were, the center of the primitive ellipsoid. Something like the remnants of an equatorial ring may also be seen above and below; abandoned, perhaps, before the ellipsoid broke.

The figure is copied from Lord Rosse's (*Phil. Trans. for* 1850, Plate XXXVII. Fig. 6), and represents H. 444.

Lord Rosse's description speaks of "tails and curved filaments; perhaps annulus around the two nebulæ." † Were the annulus, however, still *complete*, we should expect to see it most distinctly in the very regions where it is now deficient.

In *Fig.* 31 a perfect ring appears, with little or no foreshortening. The nebula has two nuclei, and the central portion appears as if produced by the crossing or interlacing of the branches of two spirals. It has "a star in the center and apparently ragged outline"; ‡ viz. something still to mark, as it were, the center of the ellipsoid, and marks of disruption and dispersion *outward*.

The figure from which this is taken (*Phil. Trans. for* 1850, Plate XXXVII. Fig. 11) represents the "great round planetary nebula" M. 97, H. 838, as seen by Lord Rosse in the 3-feet telescope.

A rather elliptical outline with two nuclei occurs in H. 1146 as the same is shown in Sir John Herschel's figure (*Phil. Trans. for* 1833, Plate XV. Fig. 71).

The like appearance, on a very small scale, may also be distinctly seen in the planetary nebula H. 3241 (*Results of Observations, &c. at the Cape*, Plate VI. Fig. 2).

"A fine double star" is symmetrically situated in "an oval nebula H. 2002," § figured by Sir John Herschel (*Phil. Trans. for* 1833, Plate X. Fig. 30).

In H. 536 and 1499 (*Phil. Trans. for* 1833, Plate XIV. Figs. 61 and 62) the two stars are situated, one at each extremity of the largest diameter. In H. 2236 and 2205 respectively (Figs. 60 and 63 of the same Plate), the stars appear more like "satellites" of the nebulæ.

Class V.

(*Nebulæ of comparatively simple Forms, but whose probable Origin cannot yet be asserted.*)

Division 1st. Some Peculiar Planetary Nebulæ.

Some instances of planetary nebulæ partially resolved have found their place in Class IV. Other peculiar instances are arranged here.

H. 461, represented by Lord Rosse (*Phil. Trans. for* 1850, Plate XXXVIII. Fig. 12), "has two stars in it," like the two nuclei in our Class IV., "and a third star suspected in the brightest part."* It has also an outline like that represented in *Fig.* 31; with a trace of but *one* spiral, or that which may be such, in so far as yet appears.

H. 2241 is also represented by Lord Rosse (*Phil. Trans. for* 1850, Plate XXXVIII. Fig. 13). It has the appearance of a ring within a ring; as though a ring had been first abandoned by the primitive central mass, and then a second one formed in accordance with the processes described, one in the case of the elliptic nebulæ, and the other in those which are annular.

H. 2098 (represented in our *Fig.* 10 *bis*) has already been alluded to (p. 110).

Lord Rosse says of it, that, "if the annular nebulæ are really hollow shells, the nebulous ring" (seen edgewise) "would cover the comparatively transparent center." †

The hypothesis of a hollow shell, here alluded to, is that suggested by Sir John Herschel, especially with respect to M. 97, H. 838, which has, however, recently been partially resolved, and furnishes the second example under our Class IV. M. Arago supposes that these envelopes shine by light reflected from a self-luminous body at their centers (*Annuaire, &c.* 1842, pp. 409–411). ‡

Now, — as was heretofore shown, in connection with the 7th and 11th coincidences in phenomena presented by the Milky Way, — a red color among the stars seems to be connected with a greater density, while an inferior density may perhaps coexist with a blue tint. If, then, the light of the planetary nebulæ, in some cases, be indeed that of a spherical shell, — i. e. of an expanded and therefore probably less dense material, — we need not be surprised to find them exhibiting the blue tint, or some approximation to it. Such we in fact find to be the description of some of them. Thus, of H. 3365 it is said: —

"Its light is about equal to that of a star of the 6.7 magnitude, its diameter about 12″, its disc circular or very slightly elliptic, and with a clear, sharp, well-defined outline, having exactly the appearance of a planet with the exception only of its color, which is a fine and full blue verging somewhat upon green. And it is not a little remarkable that this phenomenon of a blue color, which is so rare among *stars* (except when in the immediate proximity of yellow stars), occurs, though less strikingly, in three other objects of this class, viz. in" H. 3248, " whose color is sky blue, and in" H. 2098 and 2241, " where the tint, though paler, is still evident." [*]

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* The circumstances under which this very peculiar form may have been realized, the variety of which it admits, and its successive changes, will all be more distinctly considered in another connection. See remarks upon the primitive forms of the *Complex* (and especially the *Double*) *Nebulæ*.

† *Phil. Trans. for* 1850, p. 512.

‡ *Ibid.*

§ *Phil. Trans. for* 1833, p. 460.

* Quotations are from *Phil. Trans. for* 1850, p. 513.

† *Ibid.*, p. 507.

‡ On which see Sir John Herschel's note to (877) of his *Outlines of Astronomy*.

The last two of the nebulæ here mentioned have been shown to have appendages; 2241 exhibiting the two rings already spoken of, and 2098 the appearance represented in our *Fig.* 10 *bis*, as heretofore stated.

To the suggestion of a hollow shell, SIR JOHN HERSCHEL appends, in one instance, the alternative of "a flat disc presented to us (by a highly improbable coincidence) in a plane precisely perpendicular to the visual ray." [†] To present the appearance of H. 3365, such a disc must be seen somewhat obliquely. It would be strange, indeed, if this should prove to be one of *the highly oblate primitive spheroids, as yet unbroken.* [‡]

Another phenomenon connected with the arrangements of planetary nebulæ is thus noticed by SIR JOHN HERSCHEL.

"The point to which I should here draw attention is the frequent and close proximity to these objects of minute stars, which suggest the idea of accompanying satellites. Such they may possibly be. The enormous magnitude of these bodies, and consequent probable mass (if they be not hollow shells), may give them a gravitating energy, which, however rare we may conceive them to be, may yet be capable of retaining in orbits three or four times their own diameter, and in periods of great length, small bodies of a stellar character." [*]

If this be so, what seems to have been an exception, rather than a rule, among nebulæ and clusters, may have occurred in the case of these stars; viz. the formation of planetary bodies (at present self-luminous) after the manner supposed by the nebular hypothesis. (See remarks under Class I., Order 2d.)

H. 2205 is not spoken of as a planetary nebula, but LORD ROSSE's figure of it (*Phil. Trans. for* 1850, Plate XXXVI. Fig. 4) shows an arrangement not unlike the left-hand half of the nebula copied in our *Fig.* 31; the dense central portion exhibiting itself as a lateral attachment to a spiral or annular arrangement, — the outline of the whole resembling a small Roman *q* with a very short and rough stem.

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[*] SIR JOHN HERSCHEL's *Outlines of Astronomy*, (876).

[†] *Ibid.*

[‡] It might then be described, somewhat after the manner of the geologists, as being a still existing specimen of a genus, the species of which are now nearly all extinct.

[*] *Phil. Trans. for* 1833, p. 500.

(*To be continued.*)

FROM A LETTER OF DR. PETERSEN TO THE EDITOR.

Altona, 1852, *May* 21.

I HAVE made the following observations of the new comet with the ring-micrometer. That of May 17 is more accurately reduced than in the circular. The comet has been observed as follows: —

1852.	M. T. Altona.	☄ α	☄ δ	No. Comp.
	h. m. s.	° ′ ″	° ′ ″	
May 17	12 43 21.5	337 55 2.4	+71 13 4.4	4
18	11 20 3.7	337 21 17.2	73 47 5.9	4
19	12 9 40.6	336 39 12.2	+76 33 50.6	4

In Berlin.

1852.	M. T. Berlin.	☄ α	☄ δ	No. Comp.
	h. m. s.			
May 19	13 4 48.7	336° 38′ 15″.6	+76° 38′ 45″.5	10

Professor VALZ of Marseilles informs me that this comet was discovered in that city on the 15th of May, by Mr. CHACORNAC, who calls it "une petite comète, très-faible, assez diffuse, sans queue ni noyau." Professor VALZ was prevented by illness from observing it himself, but believes that the following approximate positions are tolerably correct.

1852.	M. T. Marseilles.	☄ α	☄ δ
	h. m.		
May 15	14 20	338° 30′	+66° 0′
16	15 20	338 0	+68 50

The following observations of the two new asteroids have been sent me, and may have interest for you.

PSYCHE.

At Rome, by Professor SECCHI.

1852.	M. T. Rome.	⑯ α	⑯ δ	
	h. m. s	h. m. s.	° ′ ″	
April 5	8 54 25.0	9 50 52.25	+13 40 —	Meridian-Circle.
6	8 49 42.0	50 42.55	41 29.7	"
7	8 45 37.0	9 50 33.93	+13 42 40.5	"

1852.	M. T. Rome. h. m. s.	⑯ α h. m. s.	⑯ δ ° ′ ″	
April 10	8 33 40.1	9 50 24.07	+13 45 37.2	Meridian-Circle.
11	8 29 32.2	50 12.11	46 44.6	"
12	8 25 33.7	50 9.43	47 15.5	"
13	8 21 36.9	50 8.58	——	"
15	8 13 45.8	50 9.29	48 35.5	"
18	8 2 8.7	9 50 19.92	+13 49 8.3	"
21	8 22 32.5	*a* +18.63	*a* +17 38.8	Ring-Micrometer 4
23	8 24 8.7	*a* +39.56	*a* +16 34.5	" 5
24	9 28 7.2	*a* +52.44	*a* +15 47.1	" 4
25	8 11 34.2	*a* +64.90	*a* +15 19.8	" 2
26	8 10 4.6	*a* +79.85	*a* +14 29.3	" 2

The apparent position of the star *a* was determined by the Meridian-Circle.

1852.	∗ α h. m. s.	∗ δ ° ′ ″
April 21	9 50 23.81	+13 31 0.6
24	9 50 23.97	+13 30 59.2

At Leipsic, by Professor D'Arrest.

1852.	M. T. Leipsic. h. m. s.	⑯ α ° ′ ″	⑯ δ ° ′ ″
April 25	10 7 3.5	147 52 33.0	+13 45 50.8
May 7	10 40 58.1	148 47 59.8	+13 26 48.3

THETIS.

At Leipsic, by Professor D'Arrest.

1852.	M. T. Leipsic. h. m. s.	⑰ α ° ′ ″	⑰ δ ° ′ ″
April 26	10 48 43.0	179 31 20.8	+9 7 22.6
May 7	11 11 23.4	178 53 31.4	3 36.3
7	11 26 20.6	178 53 26.2	9 3 41.6
10	10 24 5.4	178 52 3.3	8 58 22.9
11	10 24 24.8	178 52 22.8	55 49.5
15	10 53 22.6	178 58 0.1	44 43.9
16	10 42 23.3	179 0 25.8	41 31.6
17	11 10 49.5	179 3 24.4	+8 38 3.4

A. C. PETERSEN.

FROM A LETTER OF PROFESSOR RÜMKER TO THE EDITOR.

Hamburg, 1852, *May* 21.

I have observed *Thetis*, *Psyche*, and Dr. Petersen's new comet, as follows: —

PSYCHE.

1852.	M. T. Hamburg. h. m. s.	⑯ α ° ′ ″	Parall. ″	⑯ δ ° ′ ″	Parall. ″	No. Comp.
April 11	8 58 15	147 32 57.6	+0.3	+13 46 47.6	+2.2	6
16	8 46 31	147 32 52.5	0.3	49 1.2	2.2	6
23	8 59 14	147 46 6.2	0.7	47 33.0	2.1	10
25	9 31 8	147 52 20.9	1.0	45 53.9	2.2	9
26	10 16 30	147 56 11.1	1.3	44 59.6	2.2	8
May 6	10 15 22	148 47 27.4	1.5	30 46.0	2.2	13
7	9 50 13	148 53 55.6	1.3	28 40.4	2.1	4
11	10 11 20	149 22 31.8	1.5	20 8.4	2.2	12
15	10 58 22	149 55 11.7	+1.5	+13 9 40.6	+1.9	21

From April 11 till April 26, inclusive, the planet was compared with a star whose apparent place I determined with the Meridian-Circle.

1852.	∗ α h. m. s.	∗ δ ° ′ ″
April 4	9 49 10.874	+13 51 33.0

The mean place for 1852, January 1, of the comparison-star for May 6 to 15 was determined from observations of April 23 to be

∗ α h. m. s.	∗ δ ° ′ ″
9 58 39.785	+13 30 1.2

THETIS.

1852.	M. T. Hamburg. h. m. s.	⑰ α ° ′ ″	Parall. ″	⑰ δ ° ′ ″	Parall. ″	No. Comp.
April 23	10 35 13.2	179 50 10.7	+0.7	+9 3 18.0	+4.0	10
25	11 54 25.2	179 37 0.4	1.1	6 4.4	4.0	7
26	11 6 39.2	179 30 56.4	1.3	7 10.6	4.0	6
May 7	13 3 13.9	178 53 21.1	2.9	9 3 34.1	4.1	11
11	11 2 26.8	178 52 22.8	1.9	8 55 50.8	3.8	8
15	12 2 23.0	178 58 2.9	2.7	44 39.7	4.0	7
16	11 40 53.0	179 0 33.3	2.5	41 26.9	4.0	10
17	9 59 45.7	179 3 8.0	1.4	38 3.2	3.8	6
18	10 2 33.2	179 6 21.3	1.5	34 31.2	3.8	3
19	10 22 11.0	179 10 7.5	+1.6	+8 30 33.8	+3.8	9

Mean places of comparison-stars, from observations with the Meridian-Circle.

* α h. m. s.	* δ ° ′ ″
12 0 33.361	+9 4 30.9
11 55 0.106	8 53 42.6
11 52 19.977	8 46 5.0
11 53 26.203	8 44 23.9
11 55 11.372	+8 38 55.2

My son George has computed the following elements and ephemeris for *Thetis*, from observations at Bilk, April 20, and at Berlin, April 28 and May 11.

Elements of *Thetis* for 1852, May 16.5, Mean Time Berlin.

M	313° 25′ 1″.43	
π	259 10 9.11	Mean Equinox,
☊	125 3 1.63	June 0.0, 1852.
i	5 32 55.09	
ϕ	8 30 39.16	
Log. a	0.3963126	
Log. μ	2.9555377	

Ephemeris for Mean Berlin Midnight.

1852.	⑰ α h. m. s.	⑰ δ ° ′	Log. △
June 10	12 8 29	+6 21.9	
11	9 17	14.4	
12	12 10 6	+6 6.8	
June 13	12 10 55	+5 59.1	0.27116
14	11 46	51.3	
15	12 38	43.1	
16	13 32	35.4	
17	14 26	27.2	0.28051
18	15 21	19.0	
19	16 18	10.6	
20	17 16	5 2.1	
21	18 15	4 53.5	0.28969
22	19 15	44.8	
23	20 16	36.1	
24	21 18	27.2	
25	22 21	18.3	0.29869
26	23 25	9.2	
27	24 30	4 0.1	
28	25 36	3 50.9	
29	26 42	41.6	0.30750
30	12 27 50	+3 32.3	

DR. PETERSEN'S COMET.

1852.	M. T. Hamburg. h. m. s.	☄ α ° ′ ″	☄ δ ° ′ ″	Comp.
May 18	11 48 29.6	337 23 39.6	+73 49 42.6	3
19	11 58 34.0	336 40 10.3	+76 32 44.3	3

This comet was seen still earlier in Marseilles.

C. RÜMKER.

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From a Letter of Professor Rümker to the Editor.

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OBSERVATIONS OF ENCKE'S COMET, OF FLORA, AND OF EGERIA, MADE AT THE OBSERVATORY OF HAMBURG.

By PROFESSOR C. RÜMKER.

ENCKE'S COMET.

1852.	M. T. Hamburg	☄ α	Parall.	☄ δ	Parall.	No. of Comp.
	h. m. s.	° ′ ″	″	° ′ ″	″	
Jan. 20	6 43 6.0	348 47 4.0	+2.7	+4 50 2.0	+4.5	14
22	6 43 53.2	349 28 17.6	2.8	5 3 20.0	4.5	8
26	6 41 32.3	350 54 9.6	3.2	5 32 20.6	5.0	20
27	6 37 1.8	351 16 41.1	3.2	5 39 23.5	5.0	2
Feb. 18	7 43 55.5	0 54 8.7	4.3	8 39 58.8	5.8	10
19	7 20 41.6	1 22 39.6	4.3	8 47 20.3	5.6	7
20	7 11 11.7	1 51 11.4	4.3	8 53 48.7	5.8	17
23	7 17 17.4	3 17 49.8	4.6	9 10 47.7	6.0	20
24	7 17 23.8	3 45 55.6	4.6	9 15 19.6	6.1	9
25	7 49 44.2	4 14 11.1	4.8	9 18 23.0	6.3	4
27	7 5 23.8	5 23 49.6	4.9	9 32 40.1	6.4	5
March 1	7 24 15.5	6 15 55.4	5.3	9 13 43.1	7.0	13
2	7 5 16.4	6 34 46.1	5.5	9 6 58.3	7.1	3
4	7 18 27.6	7 4 31.9	5.7	8 43 25.5	7.4	7
5	7 6 5.2	7 13 50.0	5.9	8 26 31.9	7.7	7
8	7 6 56.5	7 9 52.6	6.3	7 5 56.0	8.2	2
9	7 2 14.6	7 1 36.7	+6.6	+6 45 54.8	+8.7	1

The annexed parallax is not yet applied to the observations. The apparent places of the comparison-stars are mostly derived from my observations with the Meridian-Circle.

Apparent Places of Comparison-Stars.

1852.	✱ α	✱ δ
	h. m. s.	° ′ ″
Jan. 20	23 12 46.557	+4 34 20.8
	23 14 29.576	4 31 31.7
22	23 20 42.470	5 15 32.2
	23 20 55.017	4 59 30.7
26	23 22 48.812	5 36 31.1
27	23 22 48.806	5 36 31.0
Feb. 18	0 4 10.520	8 18 51.9
19, 20	0 7 46.090	8 55 35.0
23	0 12 50.260	9 6 45.0
24	0 12 50.250	9 6 44.9
	0 19 14.060	9 19 37.9
	0 20 39.458	+9 22 37.8
Feb. 25	0 19 14.059	+9 19 37.9
	0 20 39.458	9 22 37.8
27	0 21 51.235	9 33 54.5
March 1	0 26 29.272	9 29 11.4
2	0 26 29.270	9 29 11.4
4	0 29 56.223	8 49 24.5
	0 33 32.098	8 32 39.9
5	0 33 32.095	8 32 39.9
8	0 36 38.812	6 57 31.5
9	0 40 59.074	+6 46 33.2

FLORA.

1852.	M. T. Hamburg.	⑧ α	Parall.	⑧ δ	Parall.	No. of Comp.	Compared Stars.
	h. m. s.	° ′ ″	″	° ′ ″	″		
March 12	10 8 6.3	190 32 45.2	—2.5	+5 21 47.2	+4.3	4	18, 20, Weisse Hor. 12, No. 838.
13	10 28 9.0	190 19 18.6	2.3	5 33 1.9	4.3	4	15.
14	11 7 44.9	190 5 29.6	1.7	5 40 42.9	4.3	7	15, 16.
15	11 6 1.8	189 51 55.1	1.6	5 48 44.5	4.3	4	15, 16.
16	8 56 21.3	189 39 17.3	3.0	5 55 19.8	4.4	1	15, 16.
17	9 16 9.5	189 25 6.5	2.8	6 3 14.2	4.4	5	15, 16, Weisse 593; Lal. 23714.
19	8 56 52.6	188 56 46.2	2.9	6 18 12.7	4.4	6	11, Weisse 572, 576, 593; Lal. 23713.
19	12 41 54.8	188 51 24.9	0.0	6 19 23.8	4.2		Meridian-Circle.
20	9 36 59.9	188 41 51.8	2.5	6 26 2.5	4.3	4	13, Weisse 572; Lal. 23692.
20	12 40 1.6	188 40 2.6	0.0	6 26 52.0	4.2		Meridian-Circle.
21	9 14 57.5	188 27 31.0	2.6	6 33 31.5	4.3	4	Weisse 572; Lal. 23692.
21	12 35 7.8	188 25 30.3	0.0	6 34 13.7	4.2		Meridian-Circle.
24	12 20 24.2	187 41 27.5	0.0	6 55 52.5	4.2		Meridian-Circle.
25	9 15 32.7	187 28 39.0	2.7	7 2 9.7	4.3	4	12, Weisse 536, 543.
25	12 15 29.6	187 26 39.0	0.0	7 2 53.1	4.1		Meridian-Circle.
28	9 25 6.1	186 43 58.1	2.7	7 22 44.1	4.3	6	Weisse 364, 367.
28	12 0 41.8	186 42 19.9	0.0	7 23 8.2	4.1		Meridian-Circle.
April 2	11 36 14.6	185 29 28.9	0.0	7 53 58.1	4.0		"
5	11 22 21.9	184 58 8.2	0.0	8 11 51.3	4.0		"
7	11 11 57.4	184 19 50.5	—0.0	+8 20 31.3	+4.0		"

Mean Places of Stars in the Geocentric Orbit of Flora, from Observations with the Meridian-Circle.

Number.	✱ α Jan. 0, 1852.	No. of Obs.	✱ δ Jan. 0, 1852.	No. of Obs.	Number.	✱ α Jan. 0, 1852.	No. of Obs.	✱ δ Jan. 0, 1852.	No. of Obs.
	h. m. s.		° ′ ″			h. m. s.		° ′ ″	
1	12 6 56.936	1	+5 8 12.4	1	11	12 32 22.077	1	+6 15 34.0	1
2	12 6 57.147	1	4 28 46.7	1	12	12 33 48.782	1	7 2 3.9	1
3	12 11 49.098	1	7 49 41.5	1	13	12 35 15.430	1	6 27 27.8	1
4	12 17 52 749	1	8 5 43.9	1	14	12 38 46.938	3	6 20 34.5	2
5	12 20 37.329	1	7 54		15	12 40 39.596	2	5 56 43.9	2
6	12 22 39.069	2	6 41 43.7	2	16	12 41 54.869	2	5 58 57.9	2
7	12 23 11.296	1	6 20 4.5	1	17	12 44 25.780	1	5 36 28.9	1
8	12 25 58.860	1	7 2		18	12 46 8.816	1	5 2 39.2	1
9	12 29 18.172	1	8 44 52.5	1	19	12 46 13.080	1	5 32 53.8	1
10	12 30 35.620	1	+6 26 58.2	1	20	12 47 51.056	2	+5 23 5.7	2

EGERIA.

1852.	M. T. Hamburg.	⑬ α	Parall.	⑬ δ	Parall.	No. of Comp.	Compared Stars.
	h. m. s.	° ′ ″	″	° ′ ″	″		
Feb. 19	9 52 57.6	184 34 26.7	—3.3	+23 14 37.7	+3.6	4	40.
20	9 19 39.3	184 24 4.7	3.3	23 19 16.2	3.9	15	40.
22	10 24 51.6	184 0 57.4	3.0	23 30 1.8	3.4	17	40.
23	8 58 5.2	183 49 46.1	3.5	23 34 46.4	3.8	24	40, 41.
24	9 2 38.5	183 37 24.7	3.5	23 39 50.0	3.8	12	39, 41.
25	8 49 42.3	183 24 50.5	3.6	23 44 33.6	3.8	12	39.
27	8 36 40.2	182 58 35.5	3.6	23 53 50.3	3.9	23	38.
29	9 30 25.8	182 30 14.4	3.3	24 2 39.4	3.5	10	35, 37, 38, 39.
March 1	8 54 18.2	182 16 14.6	3.5	24 6 35.0	3.7	11	37, 38.
4	9 14 42.3	181 31 15.3	3.3	24 17 42.3	3.6	16	33.
8	8 30 56.7	180 28 57.6	3.4	24 29 20.8	3.6	16	32.
12	8 23 19.1	179 23 50.3	3.4	24 37 12.9	3.6	13	30, 31, 32.
13	9 35 19.5	179 6 23.9	2.6	24 38 36.5	3.2	14	30, 31, 32.
14	12 24 15.0	178 47 51.5	0.0	24 39 44.0	2.8	*c*	Meridian-Circle.
15	10 28 9.6	178 32 40.4	1.8	24 40 21.3	3.0	6	27, 28, 30, Bessel's Zone 503, No. 26.
15	12 19 13.0	178 31 15.4	0.0	24 40 31.0	2.8		Meridian-Circle.
16	8 31 41.2	178 17 28.4	3.1	24 40 47.6	3.4	5	28, 30, Bessel's Zone 503, No. 26.
17	12 9 9.0	177 58 12.2	0.0	24 41 4.3	2.8		Meridian-Circle.
19	7 55 18.2	177 28 14.4	—3.3	+24 40 32.4	+3.5	5	24, 25, 27.

1852.	M. T. Hamburg.	⑬ α	Parall.	⑬ δ	Parall.	No. of Comp.	Compared Stars.
	h. m. s.	° ′ ″	″	° ′ ″	″		
March 19	11 59 6.0	177 25 19.1	—0.0	+24 40 27.1	+2.8		Meridian-Circle.
20	8 30 36.3	177 11 24.4	2.9	24 39 57.2	3.3	5	25, 27.
20	11 51 5.2	177 9 3.4	0.0	24 39 42.4	2.8		Meridian-Circle.
21	8 23 58.6	176 55 7.8	2.9	24 38 54.2	3.3	9	25.
21	11 49 4.4	176 52 45.3	0.0	24 38 45.4	2.8		Meridian-Circle.
22	8 27 51.2	176 38 57.2	2.9	24 37 36.7	3.2	17	25.
24	8 19 14.5	176 7 6.2	3.0	24 34 12.6	3.3	13	24.
24	11 34 6.6	176 5 7.9	0.0	24 34 6.1	2.8		Meridian-Circle.
25	8 7 2.1	175 51 33.9	2.9	24 32 2.2	3.3	6	24.
25	11 29 7.6	175 49 18.7	0.0	24 31 46.2	2.8		Meridian-Circle.
28	8 14 43.0	175 5 50.6	2.6	24 23 40.3	3.2	12	23, Bessel's Zone 353, No. 64.
28	11 14 18.5	175 3 49.7	0.0	24 23 28.5	2.7		Meridian-Circle.
30	8 24 6.0	174 36 41.4	2.4	24 16 46.0	3.1	4	23, Bessel's Zone 353, No. 64.
April 2	9 33 20.9	173 54 36.8	1.2	24 4 10.2	2.8	13	Bessel's Zone 353, No. 61.
2	10 49 57.7	173 53 19.9	0.0	23 3 54.9	2.7		Meridian-Circle.
5	10 35 36.6	173 14 52.4	—0.0	+23 48 50.8	+2.7		Meridian-Circle.

Mean Places of Stars in the Geocentric Orbit of Egeria.

Number.	∗ α Jan. 0, 1852.	No. of Obs.	∗ δ Jan. 0, 1852.	No. of Obs.	Number	∗ α Jan. 0, 1852.	No. of Obs.	∗ δ Jan. 0, 1852.	No. of Obs.
	h. m. s.		° ′ ″			h. m. s		° ′ ″	
1	11 12 2.223	1	+19 53 28.39	1	23	11 39 20.295	2	+24 32 29.68	2
2	11 12 25.892	2	21 21 39.80	2	24	11 45 13.767	3	24 36 14.26	3
3	11 14 7.585	1	20 16 58.98	1	25	11 46 54.613	1	24 38 8.85	1
4	11 17 19.515	1	23 27 42.79	1	26	11 48 50.220	1	24 17 50.36	1
5	11 18 26.685	1	20 17 47.88	1	27	11 51 29.419	3	24 43 48.55	3
6	11 18 26.991	1	21 12 46.02	1	28	11 52 20.984	3	24 46 1.83	2
7	11 18 41.155	1	21 20 0.74	1	29	11 55 18.900	1	25 0 4.22	1
8	11 19 20.292	1	20 30 25.91	1	30	11 56 37.549	3	24 56 35.79	3
9	11 22 21.615	1	23 25 31.90	1	31	12 0 29.486	8	24 31 32.08	8
10	11 24 14.962	1	22 40 35.91	1	32	12 0 34.963	1	24 42 50.15	1
11	11 25 5.956	1	22 48 16.83	1	33	12 6 56.935	7	24 29 23.82	7
12	11 25 35.914	1	22 23 41.77	1	34	12 8 50.963	1	24 46 5.60	1
13	11 26 53.333	1	24 9 58.72	1	35	12 10 24.268	1	23 40 35.11	1
14	11 28 55.164	1	21 12 22.41	1	36	12 11 8.761	1	24 8 20.03	1
15	11 30 56.262	1	23 11 54.58	1	37	12 11 7.052	3	23 56 33.18	3
16	11 30 59.813	2	24 8 53.20	2	38	12 11 50.218	2	23 51 25.52	2
17	11 31 8.282	1	23 36 41.71	1	39	12 13 14.245	1	23 44 13.72	1
18	11 32 31.576	1	22 12 24.12	1	40	12 14 56.727	1	23 17 9.55	1
19	11 33 4.945	1	22 10 26.33	1	41	12 15 19.272	3	23 41 43.69	2
20	11 34 46.618	1	24 43 20.68	1	42	12 17 37.205	2	23 45 6.47	2
21	11 36 4.491	1	24 49 52.87	1	43	12 22 55.084	2	+23 14 41.86	2
22	11 36 53.132	1	+23 11 55.42	1					

ELEMENTS OF THETIS.

By Mr. J. D. RUNKLE.

Orbit of *Thetis*, computed from observations made at Bilk, April 17, Vienna, April 28, and Washington, May 19. Epoch, 1852, Jan. 0, Mean Time Washington.

M	275° 35′ 40″.84	
π	259 42 13.73	Mean equinox of epoch.
☊	125 28 29.19	
ϕ	6 56 48.87	
i	5 35 45.61	
Log. a	0.3911498	
Log. μ	2.9632819	

The orbit gives for the middle place: Calc. — Obs. $\delta\lambda = +0''.71$; $\delta\beta = -0''.02$.

ON THE ORIGIN OF THE FORMS AND THE PRESENT CONDITION OF SOME OF THE CLUSTERS OF STARS AND SEVERAL OF THE NEBULÆ.

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(*Continued from page* 142.)

The stem of the *q* may perhaps be the scattered remnant of a portion of a primitive ellipsoid symmetrical to that part which is still somewhat distinctly apparent (see changes attributed to such a form, and those of Class III., Order 2d); — or else it might seem that the stem of the *q* is but the oblique projection of a portion similar to the spiral to which it is apparently attached; the density and outline of the stem, as we see it, being not inconsistent with such a supposition.

The inclination of the symmetrical planes of the two portions would then be analogous to that which is exhibited by the components of some of the *double nebulæ;* of which more hereafter.

Lord Rosse's Fig. 81 of Plate XVIII., *Phil. Trans. for* 1844, represents a cluster with the central portion not wholly unlike the oval planetary nebulæ; but with branching appendages conforming somewhat to the spirals of Class I. The locality of the cluster is not stated in the accompanying description.

Lord Rosse considers that "probably greater power would bring out other filaments, and that it would then assume the ordinary form of a cluster." [*]

The telescope employed was the largest then in use; viz. the "three-feet."

Division 2d. Stratified Cluster, and a "Fissured" Nebula.

The cluster H. 3753 is described in the catalogue as "consisting of stars of two sizes, 11 and 15, with none intermediate, as if it consisted of two layers or one shell over another." The largest of the stars of the greater magnitude are visibly reddish; as has been heretofore noticed (10th coincidence in the case of the Milky Way).

The nebula H. 3501 is represented in *Fig.* 18. The figure is a copy of Sir John Herschel's (*Results of Observations, &c. at the Cape*, Plate IV. Fig. 2).

In it there is the appearance of a spheroid from which portions immediately adjacent to the equatorial region have been violently rent away; as if the form of a hollow shell had been first produced by the divellent action of the cooled exterior; or by an internal development of force propelling the material from within outward; and that then a new and *sudden* development or action of internal force had torn away the material of the spheroid in the region of least resistance; and thus produced the separation which is still so well defined.[†]

H. 3707, 3641, and 3644 are completely resolved clusters represented in the *Results of Observations, &c. at the Cape* (Plate V. Figs. 5, 4, and 6, respectively). The stars are widely scattered in all of them.

3707 presents the appearance of a rent spheroid without the central trace in our *Fig.* 18. The resemblance of the cluster to that figure is pointed out by Sir John Herschel.[*]

3641 appears as if a spheroid had been rent into four nearly equal parts, after a ring had first been thrown off.

3644, though so widely scattered, would seem to have been mainly divided into three approximately equal portions; but almost no traces of its primitive form remain. Around the central part is a curious open arrangement along three sides of a square; which may possibly once have had the form of a convoluted nebula (Class III., Order 2d).[†]

Fig. 17 (of H. 2552) shows some resemblance to *Fig.* 18, but admits of another explanation; as heretofore suggested (concluding remarks to Class III., Order 1st).

Division 3d. Nebulous Stars.

Sir William Herschel concluded that a nebulous star properly so called owed its peculiarity to a "shining fluid" condensed around the star: that the fluid was "self-luminous," and such as was fitted "to produce a star by its condensation." [‡]

They would then seem to be analogous to the globular or the elliptic nebulæ, in their primitive state (Class I., Order 2d); but the increased optical power applied by Lord Rosse has revealed a more complicated structure in some instances; insomuch that they would seem to be like planetary nebulæ in miniature.

Thus H. 450, as represented by Lord Rosse (*Phil. Trans. for* 1850, Plate XXXVIII. Fig. 15), appears like a ring with an interior ring overloaded toward one side, (where there is the appearance of a star,) somewhat in the manner supposed in the case of the hypothetical ring (remarks introductory to Class III., Order 2d): unless, indeed, we might suppose this to be a binuclear nebula, and that one of the nuclei has become opaque. ? ?

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[*] *Phil. Trans. for* 1844, p. 322.

[†] The *smooth* passage of a musket-ball shot through glass is suggestive of what may have occurred in such a case; and all the more readily because the cohesion of the material was comparatively small. With regard to the effect of a *sudden* application of force in certain cases, we have the following conclusions of Professor Bonnycastle: —

"In producing the fracture of natural substances which all depart from the law of perfect elasticity as we approach the limit of fracture, the ratio of the effect of instantaneous and accumulative action will vary with the nature of the substance, never being less, for elastic bodies, than 2 to 1, nor for flexible than 4 to 1, and more usually approaching 3 or 4 to 1 for the former case, and 5 or 6 to 1 for the latter." — *Proceedings of the Amer. Phil. Society*, Vol. 1. pp. 191, 192.

[*] *Results of Observations, &c.*, pp. 20 and 21, respectively.

[†] If the analogy of H. 3501 (*Fig* 18) to these be yet more complete, the spaces it represents must, perhaps, be regarded as actual fissures, indicating where the spheroid was violently rent, and the material of the portions yet visible thrust asunder in directions nearly at right angles to the fissure; but if such a catastrophe be even supposable, it would not be easy to conjecture its cause.

[‡] *Phil. Trans.*, Vol. LXXXI. (for 1791), pp. 83–85.

H. 361, ι *Orionis*, is also represented by **Lord Rosse** (*Phil. Trans. for* 1850, Plate XXXVIII. Fig. 16); and shows a double star shining in a dark space of rather irregular form, not wholly unlike to that seen in our *Fig.* 11; which is perhaps, after all, analogous in some respects in its structure. The nebulosity surrounding the star in **Lord Rosse**'s figure has a circular outline, the light of which is described as being "nearly equable."[*] The structure altogether presents an appearance in some respects like that of the planetary nebula H. 464, heretofore described.

Lord Rosse states that "a small double star *n. f.* has similar openings, but they are not so easily seen";[†] and in the record of the observation of January 28, 1849: "All the stars in the neighborhood are nebulous, of these two a little *s p*, last seem to have dark spaces as in the figure."[‡]

Division 4th. Temporary Stars, and Lost or Missing Stars.

Tycho Brahe conjectured that the new star of 1572 might be formed by the sudden condensation of "cosmical vapor or nebulosity";[§] and M. **Arago** has given greater precision to the idea. After commenting upon the views of **Sir William Herschel** and others, and enumerating the successive changes in the condition of the nebulous material, until at length stars were the definitive result, M. **Arago** thus expresses himself:—

"En combien de temps une seule et même nébuleuse pourrait-elle subir toute cette série de transformations? On l'ignore absolument. Ici, il faudrait peut-être des millions d'années; là, avec d'autres conditions d'étendue, de densité et de constitution physique de la matière phosphorèscente, des périodes beaucoup plus courtes seraient suffisantes, comme l'apparition subite de l'étoile nouvelle de 1572 semblerait l'indiquer."[||]

Such sudden developments, involving as they might something like a *chemical* change of *state* and other concomitants (see pp. 99 and 100), might also be presumed to bring with them an increased rapidity of rotation, together with the other consequences which have been fully detailed in the respective cases of the spirals, spheroidal nebulæ, &c. In consequence of all these, the material, which had been rapidly condensed, would be quite speedily dispersed in all directions around the center, — *speedily* we say; for the forces we must suppose would be efficient in this case, on a scale far inferior to that of the great primitive spheroids from which whole clusters were formed: the forces then would act with concentrated energy at such very reduced distances, and the development of their action be brought about in a comparatively short time.

The sudden appearance of the star of 1572, — its great brilliancy, — its diminution from month to month, — its fading away and extinction in so far as the bare eye could discern, after about fifteen months, — and all without sensible change of position, — would then be so many facts, every one well in place.

It is not a little curious, moreover, that the changes in color which were observed, are not, upon the whole, inconsistent with the supposed changes of density and distribution of material; the red especially, as heretofore, being regarded as the index of greater density in stars.

The star was at first white, and about as bright as *Venus* when that planet is brightest; was afterward apparently as large and as bright as *Jupiter;* after that inferior to *Jupiter* and a little *yellowish;* then, as the size diminished, became *red* as *Aldebaran*, *Mars*, or α *Orionis;* then of a livid white, approaching in tint to *Saturn*, until it disappeared.[*]

The colors in question must be regarded as indicative of physical changes of some sort, independent of the peculiar phenomena of light itself; for M. **Arago** shows that we cannot suppose such changes to arise from a sensibly different velocity in the rays of different colors.[†]

It is quite evident, however, that the several considerations already presented cannot very well have place, if we admit, with **Goodricke** and others, the star of 1572 to have been the same with 945 and 1264; but M. **Arago** gives, at some length, his reasons for supposing that the star of 1572 is not periodical.[‡]

Again, with respect to color; we find that the star about the 7th magnitude in *Lepus*, discovered by Mr. **Hind** in October, 1845, was of a *scarlet* or *crimson* color.[§]

The star discovered by the same astronomer in *Ophiuchus*, April 28, 1848, — which was first of the 5.4 magnitude, and is now nearly or quite extinct, — was of a *ruddy* tint.[||]

Still another star was discovered by Mr. **Hind**, November 4, 1850 (α $1^{h.}\ 22^{m.}\ 51^{s.}$, $\delta\ +2°\ 6'\ 21''$), which is characterized as "a new or variable star, at present" (November 12, 1850) "of the 7th magnitude and of a fiery color."[¶]

Tycho Brahe conceived "the everywhere-diffused celestial

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[*] *Phil. Trans. for* 1850, p. 514.

[†] *Ibid.*, p. 508.

[‡] *Ibid.*, p 514.

[§] See **Humboldt**'s *Kosmos*, **Sabine**'s Translation, Vol. III. p. 136.

[||] *Annuaire pour* 1842, pp. 432, 433.

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[*] See **Delambre**, *Histoire de l'Astronomie Moderne*, Tome I. pp. 185, 186; and M. **Arago**'s tabular arrangement of these changes (*Annuaire pour* 1842, pp. 345, 346).

[†] *Annuaire pour* 1842, pp. 333–336.

[‡] *Annuaire pour* 1842, pp. 322–332; see also **Humboldt**'s *Kosmos*, **Sabine**'s Translation, Vol. III. p. 148.

[§] *Astronomische Nachrichten*, No. 712, and also No. 713.

[||] **Sir John Herschel**'s *Outlines of Astronomy*, (829). M. **Argelander** in a communication to the *Astronomische Nachrichten*, in May, 1849 (No. 672), concludes that the apparent size of this star may have reached its minimum between October 26, 1848, and the 20th of March of the next year.

[¶] *Astronomische Nachrichten*, No. 742.

matter to have already a certain degree of condensation in the Milky Way, where its dawning luminosity produced a mild, silvery brightness, and this he thought the reason why the new star" (of 1572), "like those of 945 and 1264, shone forth on the edge of the Milky Way itself."[*] This idea of TYCHO was, of course, antecedent to the invention of the telescope.

SIR JOHN HERSCHEL makes a more general statement with respect to the position of temporary stars, as follows: —

"It is worthy of especial notice, that all the stars of this kind on record, of which the places are distinctly indicated, have occurred, *without exception*, in or close upon the borders of the Milky Way, and that only within the following semicircle, the preceding having offered no example of this kind."[†]

This may not be without some significance in its bearing upon the 5th and 10th coincidences (p. 102 and p. 107) observable in the Milky Way.

How far the considerations already advanced in the case of *temporary* stars may also be applicable to that of *lost* or *missing stars* (not planets) would seem to be much more questionable. In so far as they have respect unto variable stars themselves, the suggestions here made may have their place among the several, and sometimes very different, conjectures and hypotheses which have been, from time to time, put forth with regard to the cause or causes of changes so very singular.

Division 5th. "*Cometic*" *Nebulæ.*

Of these there are several examples. *Fig.* 32 represents H. 3688. It is copied from SIR JOHN HERSCHEL's (*Results of Observations, &c. at the Cape*, Plate VI. Fig. 18). It is one of his figures of "cometic nebulæ attached to stars."

Nebulæ of this form might seem to be the result of an extreme case of the overloaded ring (introduction to Class III., Order 2d); [‡] nearly all of the material having been condensed toward one side before the ring broke.

It seems, however, not at all unreasonable to suppose that a great mass of nebulous material, *projected* into space, may have assumed the form of a comet with its ordinary appendages, but on an immense scale. [§] The sudden condensation of the portion analogous to the tail of the comet might afterward have furnished comparatively small stars; while the head underwent changes similar to those described in cases already considered.

One of the most remarkable of LORD ROSSE's figures is that of H. 399 (*Phil. Trans. for* 1850, Plate XXXVII. Fig. 10). It appears like a more distinct view of a cometic nebula, and the part analogous to the tail of a comet would seem to be of a conical form; or rather it may be that which is supposed to be the true form of a comet's tail. There are, besides, "two comparatively dark spaces," spoken of by LORD ROSSE, "one near the vertex and the other near the base of the cone," which, as he says, "are very remarkable." These comparatively dark spaces bring to mind those which were seen in the head of the great comet of 1680, as they are represented in DELAMBRE's *Astronomie*, Tome III., Planche VI. Fig. 78.

H. 2534 is described in the Southern Catalogue, as being a complete telescopic comet; a perfect miniature of Halley's "as seen in the night glass," "only the tail is rather broader in proportion." It is represented in the *Results of Observations, &c. at the Cape* (Plate VI. Fig. 17).

The figures of H. 399, 537, 1362, and 1509, respectively, are given by SIR JOHN HERSCHEL in the *Phil. Trans. for* 1833 (Plate XIV. Figs. 64–67).

He also observes of the open cluster H. 415 (*Phil. Trans. for* 1833, Plate XVI. Fig. 91), that, "if removed far enough to lose the stars," it "would appear as a fan-shaped nebula, with a bright point like a star at the vertex, such as is represented" in the figures last referred to.[*]

CLASS VI.

(*Primitive Form, a close approximation to a Sphere.*)

With a primitive form nearly spherical, a very slow rotation, as already shown (p. 98), might coexist; and the exposure of surface being nearly the least possible, all that has been already stated of the slow effect of radiation and the progress of central condensation, even when the approximation to a sphere was less close (Class II. Order 1st), will be more intensely true in this case. With so slow a rotation at the outset, the dynamical equilibrium might endure for a period absolutely immense; and when at last overcome, although some spiral branches might be thrown off, as in the case of the highly oblate spheroid (Class I. Order 1st), yet the whole would quite as probably be scattered by something like a simultaneous rupture. Such would seem to have been the origin of the

Globular Clusters and Nebulæ.

Of these, M. 13, H. 1968, is represented in *Fig.* 12, which is copied from SIR JOHN HERSCHEL's figure (*Phil. Trans. for* 1833, Plate XVI. Fig. 86), and shows such spiral branches as are consistent with the hypothesis of its spheroidal origin, and the subsequent rending of the primitive spheroid; together with the appropriate traces of a central condensation, and the wellnigh simultaneous rupture of the interior.

H. 1558 is also described in the Northern Catalogue as being "a fine compressed cluster, with curved appendages like the short claws of a crab running out from the main body."

So, also, H. 623 is described as being "filamentous (i. e. as if filaments hung round it; an effect probably of diverging lines of small stars, as in M. 13 . . . .)."

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[*] HUMBOLDT's *Kosmos*, SABINE's Translation, Vol. III. p. 136.

[†] *Outlines of Astronomy*, (831). The latest discovered "new or variable star" of Mr. HIND (α and δ as before stated) may perhaps prove to be an exception.

[‡] Suggested by Professor PEIRCE's remarks, relative to the form which would be assumed by a nebulous ring, brought all but in contact with the sun (p. 19 of this volume of the *Astronomical Journal*); though the circumstances are very different.

[§] Of the origin of the projectile force, more hereafter.

[*] *Phil. Trans. for* 1833, p. 503.

H. 1971, "a very rich globular cluster," . . . . "has stragglers in lines and branches extending some distance from the most condensed part."

M. 30, H. 2128, has two large "projections," one evidently curvilinear. Sir John Herschel has given a very distinct figure of it (*Phil. Trans. for* 1833, Plate XVI. Fig. 90).

Of H. 3778, in the Southern Catalogue, it is said: "The stars are of two magnitudes, the larger, 11 m, run out in lines like crooked radii. The smaller, 16 m, are massed together in and round the middle."

Lord Rosse also remarks, that "in the exterior stars of some clusters there appears to be a tendency to an arrangement in curved branches, which cannot well be unusual or accidental." He specifies H. 480, 1916, and 1972 as objects in which such a "peculiarity" was suspected,* as well as 1968, of which Sir John Herschel has given the description already quoted.

That instances of the occurrence of spiral branches should be multiplied, as discovery advances, is to be expected; but they seem to be, as yet, comparatively quite few; while the number of globular clusters is very great.

In view of the hypothesis of their spheroidal origin here proposed, we ought, as already intimated, to regard the occurrence of spiral branches to a globular cluster as being the exception rather than the rule; the equilibrium having endured so long, that a wellnigh simultaneous rupture of the whole mass would seem to have been by far the more usual catastrophe. Yet, even in such a case, some tendency to a curvilinear arrangement of the exterior stars is to be looked for; and the magnificent cluster H. 3504 (*ω Centauri*) seems not to be without a semblance of it, as seen in Sir John Herschel's figure (*Results of Observations, &c.*, Plate V. Fig. 7).†

Of Complex Nebulæ.

1st. *Double Nebulæ.*

It has already been intimated, that the primitive form of some of the binuclear nebulæ might be an ellipsoid with three unequal axes. This form, in the case of a homogeneous mass, admits of considerable variety; as one of the determining quantities is directly dependent upon the centrifugal force of rotation, and inversely, upon the density.‡ Also, the nearer the shorter equatorial axis approaches to an equality with the polar in any case, the longer will be the greatest equatorial, or longest axis of all; and in the one of two extreme cases (that in which the angular velocity is zero, or the spheroid would not turn at all), the shorter equatorial axis would be equal to the polar axis, and the longer equatorial axis be infinite; or *this* extreme limit of form is "a cylinder extending indefinitely on either side of the base, which is a circle having" the polar semi-axis "for its radius." The other limit of form is that stated in the note to this paragraph.*

Mr. Ivory, at the close of his paper, more than intimates that such a form of equilibrium as is supposed in the case of the rotating ellipsoid with three unequal axes, must be very unstable; for he says: "It seems difficult to admit that any circumstances, or the action of any forces we are acquainted with, could induce upon a mass of fluid a figure adjusted with such mathematical nicety to the attraction of the mass and the centrifugal force. If the existence of such a figure can be supposed, would it be permanent? Would not the least action of" "other bodies" "be sufficient to destroy the exact conformation on which the equilibrium depends, and leave the fluid to adjust its figure by the attraction and the centrifugal force of its particles?"

Yet the formation of such an ellipsoid, or an approximation to the same, having for its semi-axes such as are admissible between the limits already specified, would seem itself to have been facilitated by circumstances in the case of the elongated fragments thrown off in the rending of the primitive spheroid (if such existed), in the instance of the Milky Way; — the portions thus rent away being, among other things, nearly homogeneous with respect to density.

The very way, moreover, in which such a figure is likely to be destroyed, and the mass broken up, we may perhaps learn from the experiments of M. Plateau, alluded to, to some extent (p. 107), in the description of the 11th special coincidence found in the Milky Way.

M. Plateau, as heretofore stated, suspended a mass of olive oil in a mixture of alcohol and water of the same specific gravity with the oil. By the aid of two thin metallic rings, he contrived to give the mass of oil the form of a cylinder with spherical segments attached to its bases. When the ratio of the length of the cylinder to its diameter did not exceed a certain limit included between the numbers 3 and 3.6, the cylindrical

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* *Phil. Trans. for* 1850, p. 506.

† If these and other clusters be the remnants of masses whose dynamical equilibrium has been destroyed, then must also the more condensed clusters be very possibly those in which the catastrophe has been the most *recent*; a conclusion the reverse of that to which Sir William Herschel was led in view of his hypothesis of the continued and cumulative effect of "*the clustering power.*" (See especially *Phil. Trans. for* 1814, p. 283.)

‡ In Mr. Ivory's paper, before quoted (*Phil. Trans. for* 1838, pp. 60 and 59, respectively), we have the determining factor $q = \frac{f}{\frac{4\pi}{3}\varrho}$; in which f denotes "the intensity of the centrifugal force at the distance equal to unit from the axis of rotation," and "ϱ is put for the density."

* Mr. Ivory's symbols for the three semi-axes are respectively k, $k\sqrt{1+\lambda^2}$ and $k\sqrt{1+\lambda'^2}$, λ being greater than λ'. In the course of his investigation he finds "that $\lambda\,\lambda'$ must be contained between the limits 1.9414 and 1, while $(\lambda - \lambda')^2$ varies from zero to be infinitely great. One limit is when $\lambda = \lambda'$, being a spheroid of revolution of which the axes are

$$k \text{ and } k\sqrt{2.9411} = k \times 1.7150.$$

Supposing λ and λ' to vary from this extreme, when the first increases, the other will decrease; so that when λ is infinitely great, λ' will be zero; which proves that the other extreme limit is a cylinder" like that described in the text. (*Phil. Trans. for* 1838, pp. 63, 64) form could be indefinitely maintained; but when, by a special manipulation, he succeeded in forming a cylinder in which the ratio was 3.6, the cylinder did not continue, but an enlargement of its thickness occurred at some places, and a contraction of the same at others, until at length the mass separated itself into *two* portions.

With reference to cylinders of greater length, M. Plateau says:—

"Je suis parvenu, par d'autres moyens, à réaliser des cylindres liquides ayant une longeur très-considérables relativement à leur diamètre, et j'ai reconnu qu'un semblable cylindre, abandonné à lui-même, se transforme spontanément en une série de sphères isolées égales en diamètre, également espacées, ayant leurs centres rangés sur la droite qui formait l'axe du cylindre, et dans les intervalles desquelles se trouvent des sphérules de différents diamètres, disposées aussi suivant l'axe de la figure." *

Now, the experiments thus specified may be accepted as suggestive of what may have occurred in the case of the *elongated* fragments of the great primitive spheroid, themselves approximating, as they were rent and scattered, to the form and structure of the homogeneous ellipsoid in question.

In accordance with what has heretofore been suggested (p. 114), the probable contraction of the outer portion of the fragment thus torn off (due to the cooling of the surface and of the region *somewhat beneath the surface*) would supply a force *analogous* to the *molecular action* at the surface of the experimental mass, but scarcely more than *proportionate* to the scale of magnitude of the great fragment itself.

Such a cooling of the highly heated exterior portion of that fragment might take place *before* the temporary (because unstable) equilibrium of a mass so vast in size and inertia could be otherwise unsettled. For, although the breaking of the fragmentary portion of the primitive spheroid may be described as being (comparatively) a *momentary* change; yet the standard of comparison which the use of that term would imply must be a period of many centuries in duration, such as may be presumed to be occupied in one rotation (as a whole) of the now scattered fragments of our cluster.

With the exception of the effects produced in the cooled exterior region, the great fragment in question must be presumed to have been nearly homogeneous in density, and not very much disturbed in its form by the action of other forces acting *across* the elongated mass.

Apart, therefore, from the effects which might arise from a change analogous to a chemical change of state,—we may (in view of all that has been stated) perhaps regard the mode of separation of the small experimental mass as being *imitative* of what occurred in the fragment of the spheroid; viz. either a separation into *two* portions,—thus furnishing the components of a *binary* star,—or else, in the instance of a more elongated fragment, into the more numerous components of a *multiple* star; the individuals being of *two very different classes as respects size*, but yet admitting of at least a subsidiary arrangement in a binary system with the two components thus unequal.

The possible effect of sudden changes in superinducing a separation into portions exhibiting different colors, has heretofore been considered (p. 108).

What has been here supposed to occur in the case of a fragment of a primitive spheroid may be, in its turn, indicative of what happened in some instances of primitive ellipsoids, from which *double* nebulæ were perhaps derived.

The cooling and consequent condensation of such an ellipsoid would especially take place in the portions both of greatest proportionate surface and the least subject to the control of the attractive force of the mass; i. e. most probably in the equatorial region (as in the spheroid) and also toward the extremities of the longest diameter.

Two nuclei of condensation being thus established, the unstable equilibrium would most probably be destroyed by a progressive accumulation around them, which might at length divide the ellipsoid into *two* separate portions, with a rotation of each around its own nucleus, in a more stable form, as already supposed in the case of *binuclear* nebulæ. The division into two great portions might well be accompanied by a central "spherule" (derived from the region least exposed to the action of divellent forces), as in the *imitative* instances already described.

On a recurrence to *Fig.* 8, we may see all the features here described as it were *realized* in the binuclear nebula which that figure represents; it having, moreover, undergone the subsequent changes (indicated by the curved branches) which have been heretofore noticed (p. 141); and still having traces of the original form visible on opposite sides of the central arrangement; which seem to require that the whole should be described as being a *binuclear* rather than a *double* nebula. Indeed, the record of one observation says, "Lower streak seems to reach the filament of the right-hand nucleus." *

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* *Annales de Chimie et de Physique*, 3^e Série, Tome XXX. p. (211).

* *Phil. Trans. for* 1850, p. 512.

(*To be continued.*)

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ON THE ORBIT OF THE GREAT COMET OF 1843.

By PROFESSOR J. S. HUBBARD.

(*Concluded from* Vol. II. p. 57.)

§ 8.

THE comparison of the observations of February 28 and the filar-micrometer series with an ephemeris computed from Elements VI. gave the following residuals: —

M. T. Berlin.	Place.	C. — O
		″
Feb. 28.35498	Portland,	—11.1
28.39471	Chihuahua,	—30.2
28.43750	"	+ 7.9

Place.	M. T Berlin.	$\Delta\alpha$	M. T. Berlin.	$\Delta\delta$
	d.	″	d.	″
Cape,	March 5.28155	+36.8	0.28688	+11.4
"	6.28589	(—47.4)	.28589	+ 4.3
"	8.30759	+ 3.1	.31265	+14.0
"	9.30513	+10.1	.30803	+13.2
"	10.30154	— 3.4	.30530	—12.9
"	11.33687	—17.7	.33687	(+87.5)
"	13.31715	+ 3.9	.32191	+ 2.3
"	14.30440	+ 0.9	.30948	+ 4.3
"	16.34418	—13.8	.34670	+ 2.0
"	18.32175	—10.4	.32397	+ 3.2
"	19.34612	+ 1.2	.35145	+ 5.5
Philadelphia,	.54960	— 0.5	.54960	— 6.3
Berlin,	20.32711	+ 1.3	.32711	— 0.8
"	21.32697	+ 5.4	.32697	+ 1.7
Cape,	22.31059	— 0.7	.31367	+ 1.2
Berlin,	.32682	— 0.9	.32682	+ 8.0
Philadelphia,	.56366	— 8.9	.56366	+ 8.4
"	23.55878	— 6.5	.55878	—19.7
Berlin,	24.32651	— 3.1	.32651	+ 7.7
Philadelphia,	.54950	— 0.2	.54950	+ 1.6
Cape,	25.30383	+ 7.0	0.30750	+ 4.7
Berlin,	March 25.32636	— 4.2	0.32636	+ 7.9
"	26.32620	+ 3.3	.32620	+ 5.4
Philadelphia,	.55565	+ 8.8	.55565	—27.9
Berlin,	27.32604	+ 1.4	.32604	— 6.3
"	28.32588	— 1.8	.32588	— 2.8
"	29.32571	— 3.4	.32571	— 6.3
"	30.32555	+10.7	.32555	+ 7.4
Cape,	31.32342	+ 0.2	.32754	+ 1.0
Berlin,	.32539	— 8.4	.32539	—12.4
Philadelphia,	April 1.57146	+22.2		
Cape,	2.30654	— 7.1	.30998	+ 5.6
Philadelphia,	.56279	— 1.2	.56279	+ 4.2
Cape,	3.30622	+ 1.1	.31014	+ 7.8
"	5.31322	—11.0	.31687	+ 7.9
"	7.29416	+ 2.6	.29784	+ 7.8
Philadelphia,	.56478	+15.8		
Cape,	8.27904	— 4.5	.28348	+ 7.7
"	9.27672	+ 1.2	.28142	+25.4
Berlin,	15.32289	+40.7	.32289	— 7.5
Cape,	18.30313	—33.7	.30712	— 2.1
"	19.29025	— 3.4	0.29423	+ 9.8

To each of these residuals I have given the weight of unity, and in the cases where two or three occur on the same date, the mean result has received the weight of $\sqrt{2}$ and $\sqrt{3}$, respectively. In forming the new equations by GÖTZE's method, instead of computing from the coefficient of

$$\Delta\psi = \Delta\omega + \cos i . \Delta n,$$

that of $\Delta\omega$, I preferred to retain the former, reserving the transformation until the results should be obtained. The unknown quantities are connected with the corrections of the elements by the equations.

$$\Delta T = 0^{d}.001 . \mathrm{p}$$
$$\Delta n = 10'' . \mathrm{q}$$
$$\Delta\psi = 10 . \mathrm{r}$$
$$\Delta i = 1 . \mathrm{s}$$
$$\Delta q = 0.000001 . \mathrm{t}$$
$$\Delta e = 0.000001 . \mathrm{u}$$

The final equations are,

$$\begin{array}{rrrrrrrl}
974.35874\,.\,p & -\;2.45029\,.\,q & +445.68425\,.\,r & +\;1.66314\,.\,s & -\;93.27208\,.\,t & -330.34245\,.\,u & -21.81721 & = 0\\
-\;2.45029\,.\,p & +57.13080\,.\,q & +\;3.80122\,.\,r & -33.85625\,.\,s & -\;0.01841\,.\,t & +\;3.34675\,.\,u & -90.81445 & = 0\\
445.68425\,.\,p & +\;3.80122\,.\,q & +922.63089\,.\,r & -\;3.42939\,.\,s & -233.74287\,.\,t & -507.61013\,.\,u & -\;3.09313 & = 0\\
1.66314\,.\,p & -33.85625\,.\,q & -\;3.42939\,.\,r & +20.23926\,.\,s & +\;0.47131\,.\,t & -\;2.13603\,.\,u & +51.22818 & = 0\\
-\;93.27208\,.\,p & -\;0.04841\,.\,q & -233.74287\,.\,r & +\;0.47131\,.\,s & +\;60.50777\,.\,t & +127.22451\,.\,u & -10.06585 & = 0\\
-330.34245\,.\,p & +\;3.34675\,.\,q & -507.61013\,.\,r & -\;2.13603\,.\,s & +127.22451\,.\,t & +295.27543\,.\,u & -\;6.35087 & = 0
\end{array}$$

whence I obtained, by elimination,

$$\begin{array}{llll}
\text{Log.}\ (aa\,.\,5) = 1.4815700 & (nn\,.\,6) = 9387''.832 & \text{Log.}\ p = {}_n0.5438032 & \Delta T = -0^{\text{d.}}.0031979\\
\text{Log.}\ (bb\,.\,5) = 8.8148467 & (nn\,.\,6) = 9387.818 & \text{Log.}\ q = {}_n1.8548745 & \Delta n = -11'\ 55''.94\\
\text{Log.}\ (cc\,.\,5) = 0.9769018 & (nn\,.\,6) = 9387.793 & \text{Log.}\ r = 0.5073112 & \Delta \omega = -\ 9\ \ 9.41\\
\text{Log.}\ (dd\,.\,5) = 8.3188887 & (nn\,.\,6) = 9387.801 & \text{Log.}\ s = {}_n2.0969349 & \Delta i = -\ 2\ \ 5.01\\
\text{Log.}\ (ee\,.\,5) = 9.2282977 & (nn\,.\,6) = 9387.719 & \text{Log.}\ t = 1.7140646 & \Delta q = +.000051768\\
\text{Log.}\ (ff\,.\,5) = 9.8882469 & (nn\,.\,6) = 9387.727 & \text{Log.}\ u = {}_n1.3172728 & \Delta e = -.000020762
\end{array}$$

The probable error of a single observation = ±8''.437.

Substituting these values of p, q, &c. in our equations, we obtain,

		C. — O.
Feb. 28	Distance from sun,	— 5''.7
28	Altitude of comet,	—28.9
28	" "	+10.3

Date.	C. — O. $\Delta\alpha$	C. — O. $\Delta\delta$	Date.	C. — O. $\Delta\alpha$	C. — O. $\Delta\delta$
March 5	+25''.7	+12''.9	March 23	— 4''.2	—22''.2
6		+ 4.9	24	+ 0.6	+ 3.1
8	— 3.6	+13.6	25	+ 4.6	+ 5.5
9	+ 4.5	+12.2	26	+10.9	—19.3
10	— 7.2	—14.2	27	+ 2.7	— 8.6
11	—20.0		28	— 0.8	— 5.1
13	+ 3.3	+ 0.1	29	— 2.7	— 8.5
14	+ 1.2	+ 2.0	30	+10.9	+ 5.2
16	—12.0	— 0.5	31	— 5.8	—11.1
18	— 8.0	+ 0.1	April 1	+21.4	
19	+ 4.2	— 4.2	2	— 6.9	+ 4.2
20	+ 6.8	— 3.4	3	0.0	+ 5.9
21	+ 7.8	— 0.9	5	—12.8	+ 6.1
22	— 1.9	+ 5.8	7	+ 9.5	+ 6.2

Date.	C. — O. $\Delta\alpha$	C. — O. $\Delta\delta$	Date.	C. — O. $\Delta\alpha$	C. — O. $\Delta\delta$
April 8	— 7''.3	+ 6''.2	April 18	—38''.8	— 2''.7
9	— 2.9	+24.0	19	— 8.7	+ 9.3
15	+36.0	— 8.4			

An independent computation for the dates of March 8 and April 19 gave,

	C. — O. $\Delta\alpha$	C. — O. $\Delta\delta$
March 8	—3''.8	+14''.2
April 19	—8.4	+ 9.8

The above corrections give Elements VII., and the values of $(aa\,.\,5)$, $(bb\,.\,5)$, &c., combined with the probable error of a single observation, having regard to the relations between the unknown quantities and the corrections of elements, furnish the probable errors of the elements as given below.

	Elements VII.	Probable Errors.
T	1843, Feb. 27$^{\text{d.}}$.4477333, M. T. Berlin,	±0$^{\text{d.}}$.001532
n	1° 14' 54''.99 M. Equinox, 1843.0	± 330''.20
ω	82 34 37.87	± 269.63
i	144 19 21.31	± 56.46
q	0.005538300	±0.000020512
e	0.999915717	±0.000009595

§ 9.

The period corresponding to the above values of q and e is 532$^{\text{y.}}$.7. By taking the extreme values of q and e we might obtain the greatest and least period consistent with the probable limits of error. But a better estimate of the amount of uncertainty attributable to the semi-axis major may be obtained by rendering the elements themselves, and consequently the residuals and the probable error of a single observation, all functions of the eccentricity, whence a mere inspection will show the amount by which this element, and through it the value of a, and the periodic time, may be varied without too great violence to the observations. If, recurring to our equations just solved, we unite $an + af$, $bn + bf$, $cn + cf$, $dn + df$, $en + ef$, $nn + 2fn + ff$, still considering the products involving f as functions of Δe, but treating the polynomial as though it were a single term, our process of elimination will be suspended at the last step but one, and we shall obtain, instead of Δq, $\Delta q +$ a function of Δe, and consequently all the other corrections of elements with a similar function. We have thus, Δe being always expressed in units of the tenth decimal place,

$$\begin{array}{ll}
p = & -\,[9.4747847] + [9.1879403]\,.\,\Delta e\\
q = & -\,[0.7648016] + [0.5009132]\,.\,\Delta e\\
r = & [0.5449431] + [8.1468719]\,.\,\Delta e\\
s = & -\,[1.0829401] + [0.7355460]\,.\,\Delta e\\
t = & [1.1252820] - [0.2673253]\,.\,\Delta e
\end{array}$$

The corrections thus obtained, applied to Elements VI., give,

$$\begin{array}{rlll}
T = & \text{Feb. } 27^{\text{d.}}.4509328 & + [2.18794] \,.\, \Delta e & \\
n = & 1^\circ\, 25'\, 52''.75 & + [7.50091] \,.\, \Delta e & \\
\omega = & 82\;\; 43\;\; 35.09 & + [7.41300] \,.\, \Delta e & \\
i = & 144\;\; 21\;\; 14.22 & + [6.73555] \,.\, \Delta e & \\
q = & 0.005499876 & - [0.26733] \,.\, \Delta e & \\
e = & 0.999936479 & + \qquad\quad \Delta e &
\end{array}$$

$$\begin{aligned}
(nn\,.\,6) &= 9720''.994 + [7.50655] \,.\, \Delta e + [1.88825] \,.\, \Delta e^2 \\
&= 9720.994 + [1.88825] \,\{(\Delta e + [5.31727])^2 - [0.63455]\} \\
&= 9387.727 + [1.88825] \,\{\, \Delta e + 0.000020762\}^2.
\end{aligned}$$

This value of $(nn\,.\,6)$ is a minimum for $\Delta e = -0.000020762$, which is the same value as found above from the first solution of our equations, and applying this value to the elements just given, we come back to Elements VII. now rendered more general, as follows: —

Final Elements.

$$\begin{array}{rllll}
T = & \text{Feb. } 27^{\text{d.}}.4477333 & + [2.18794] \,.\, \Delta e & \text{M. T. Berlin} \\
n = & 1^\circ\, 14'\, 54''.99 & + [7.50091] \,.\, \Delta e & \text{Mean Equinox, 1843.0.} \\
\omega = & 82\;\; 34\;\; 37.87 & + [7.41300] \,.\, \Delta e & \\
i = & 144\;\; 19\;\; 21.31 & + [6.73555] \,.\, \Delta e & \\
q = & 0.005538300 & - [0.26733] \,.\, \Delta e & \\
e = & 0.999915717 & + \qquad\quad \Delta e &
\end{array}$$

$$\begin{aligned}
(nn\,.\,6) &= 9387''.727 + [1.88825] \,.\, \Delta e^2 \\
&= 9387.727 \,\{1 + [7.91569] \,.\, \Delta e^2\}
\end{aligned}$$

If tan. $\theta = [3.95784] \,.\, \Delta e$, the probable error of a single observation will be $= \pm 8''.437 \,.\, \sec.\ \theta$.

By the equations of condition, we now obtain, by substituting the coefficients of Δe, the following values of the residuals: —

Feb. 28	$-\ 5''.7$	$-[5.6830] \,.\, \Delta e$
28	-28.9	$-[5.1818] \,.\, \Delta e$
28	$+10.3$	$-[5.5478] \,.\, \Delta e$

Date.	$\Delta\alpha$	$\Delta\delta$
March 5	$+25''.7 + [5.4594] \,.\, \Delta e$	$+12''.9 - [5.0828] \,.\, \Delta e$
6		$+\ 4.9 - [4.9912] \,.\, \Delta e$
8	$-\ 3.6 + [5.4082] \,.\, \Delta e$	$+13.6 - [4.6990] \,.\, \Delta e$
9	$+\ 4.5 + [5.3692] \,.\, \Delta e$	$+12.2 - [4.4771] \,.\, \Delta e$
10	$-\ 7.2 + [5.2430] \,.\, \Delta e$	$-14.2 - [4.1461] \,.\, \Delta e$
11	$-20.0 + [5.1673] \,.\, \Delta e$	
13	$+\ 3.3 + [4.8865] \,.\, \Delta e$	$+\ 0.1 + [4.3424] \,.\, \Delta e$
14	$+\ 1.2 + [4.5051] \,.\, \Delta e$	$+\ 2.0 + [4.4472] \,.\, \Delta e$
16	$-12.0 - [3.8451] \,.\, \Delta e$	$-\ 0.5 + [4.5563] \,.\, \Delta e$
18	$-\ 8.0 - [4.5441] \,.\, \Delta e$	$+\ 0.1 + [4.6021] \,.\, \Delta e$
19	$+\ 4.2 - [4.8865] \,.\, \Delta e$	$-\ 4.2 + [4.7243] \,.\, \Delta e$
20	$+\ 6.8 - [4.7076] \,.\, \Delta e$	$-\ 3.4 + [4.5798] \,.\, \Delta e$
21	$+\ 7.8 - [4.7482] \,.\, \Delta e$	$-\ 0.9 + [4.5798] \,.\, \Delta e$
22	$-\ 1.9 - [4.9868] \,.\, \Delta e$	$+\ 5.8 + [4.5563] \,.\, \Delta e$
23	$-\ 4.2 - [4.7482] \,.\, \Delta e$	$-22.2 + [4.4914] \,.\, \Delta e$
24	$+\ 0.6 - [4.8751] \,.\, \Delta e$	$+\ 3.1 + [4.5911] \,.\, \Delta e$
25	$+\ 4.6 - [4.8451] \,.\, \Delta e$	$+\ 5.5 + [4.5682] \,.\, \Delta e$
26	$+10.9 - [4.9494] \,.\, \Delta e$	$-19.3 + [4.4771] \,.\, \Delta e$
March 27	$+\ 2''.7 - [4.5798] \,.\, \Delta e$	$-\ 8''.6 + [4.2553] \,.\, \Delta e$
28	$-\ 0.8 - [4.4914] \,.\, \Delta e$	$-\ 5.1 + [4.1461] \,.\, \Delta e$
29	$-\ 2.7 - [4.3979] \,.\, \Delta e$	$-\ 8.5 + [3.9542] \,.\, \Delta e$
30	$+10.9 - [4.1761] \,.\, \Delta e$	$+\ 5.2 + [3.7782] \,.\, \Delta e$
31	$-\ 5.8 - [4.0414] \,.\, \Delta e$	-11.1
April 1	$+21.4 + [4.0414] \,.\, \Delta e$	$+ \quad 0 \,.\, \Delta e$
2	$-\ 6.9 + [4.1139] \,.\, \Delta e$	$+\ 4.2 - [4.1461] \,.\, \Delta e$
3	$0.0 + [4.2304] \,.\, \Delta e$	$+\ 5.9 - [4.1139] \,.\, \Delta e$
5	$-12.8 + [4.5051] \,.\, \Delta e$	$+\ 6.1 - [4.3979] \,.\, \Delta e$
7	$+\ 9.5 + [4.8261] \,.\, \Delta e$	$+\ 6.2 - [4.5441] \,.\, \Delta e$
8	$-\ 7.3 + [4.8129] \,.\, \Delta e$	$+\ 6.2 - [4.6232] \,.\, \Delta e$
9	$-\ 2.9 + [4.7782] \,.\, \Delta e$	$+24.0 - [4.6721] \,.\, \Delta e$
15	$+36.0 + [4.9512] \,.\, \Delta e$	$-\ 8.4 - [4.9138] \,.\, \Delta e$
18	$-38.8 + [4.9912] \,.\, \Delta e$	$-\ 2.7 - [4.9956] \,.\, \Delta e$
19	$-\ 8.7 + [4.9912] \,.\, \Delta e$	$+\ 9.3 - [5.0170] \,.\, \Delta e$

Since $a\,(1 - e) = q$, and since $d\,q$ is now a function of $d\,e$, we obtain, for any assumed value of $d\,a$,

$$d\,e = \frac{1 - e}{(a - [0.26733])} \,.\, d\,a,$$

and computing the value of a corresponding to any given periodic time, the difference between this and the a of Elements VII. substituted in the last equation will give the corresponding value of Δe, from which we can immediately learn the elements and residuals which answer best to the given conditions. We will try but one case. An identity of this comet with that of 1668 has been considered highly probable from the great similarity of their physical phenomena. This would require a period of 175 years, and the corresponding value of Δe required is $= -0.0000985641$, which, substituted in the above elements and residuals, gives,

$$
\begin{aligned}
T &= \text{Feb. } 27^{\text{d}}.4325397 \\
\pi &= \;\;\;0^{\circ}\ 22'\ 51''.57 \\
\omega &= 81\ 52\ \ 6.81 \\
i &= 141\ 10\ 25.18 \\
q &= 0.005520711 \\
e &= 0.999817153
\end{aligned}
$$

		C. − O.
Feb. 28	Distance from sun,	+41″.8
28	Altitude of comet,	−13.9
28	" "	+45.1

Date.	$\Delta\alpha$	$\Delta\delta$	Date.	$\Delta\alpha$	$\Delta\delta$
March 5	− 2″.7	+24″.8	March 26	+19″.6	−22″.3
6		+14.6	27	+ 6.4	−10.4
8	−28.9	+18.5	28	+ 2.2	− 6.5
9	−18.6	+15.2	29	− 0.3	− 9.4
10	−24.4	−12.9	30	+12.4	+ 4.6
11	−34.5		31	− 4.7	−11.1
13	− 4.3	− 2.1	April 1	+20.3	
14	− 1.3	− 0.8	2	− 8.2	+ 5.5
16	−11.3	− 4.0	3	− 1.7	+ 7.2
18	− 4.6	− 3.9	5	−16.0	+ 8.6
19	+11.8	− 9.4	7	+ 2.9	+ 9.6
20	+11.8	− 7.1	8	−13.7	+10.4
21	+13.4	− 4.6	9	− 8.8	+28.6
22	+ 7.7	+ 2.2	15	+27.1	− 0.3
23	+ 1.3	−25.3	18	−48.5	+ 7.1
24	+ 8.0	− 0.8	19	−18.4	+19.6
25	+11.5	+ 1.8			

The probable error of a single observation $= \pm 11''.32$. So far, then, as the data employed and the calculations based upon them can be relied upon, the hypothesis of the identity of this comet with that of 1668 is not sustained.

The probable error of a single observation in a parabolic orbit becomes, by substituting the value of $(1-e)$ given by Elements VII. in the formula above, $= \pm 10''.62$. Both this and the probable error belonging to the orbit of 175 years are less than we have previously found for the ring-micrometer observations, and when we notice also that only the smaller coefficients of Δe in the table of residuals occur at dates where observations were in the hands of computers in 1843, we see the apparent justice of NICOLAI's remark,* that "the transition from a period of 175 years to one of infinity makes almost no difference in the representation of observations." The addition, since that time, of the observations of February 28 and the series at the Cape of Good Hope, has enabled us to assign narrower, though still extended, limits for the periodic time. How far the operation of polar force in the comet itself, — a force of whose existence we can now have no doubt, — or of the want of coincidence of the center of gravity with the center of apparent condensation, may modify conclusions drawn irrespective of these causes, is a question not perhaps too difficult for theory, if our observations possessed more value. But our observations must be affected with a smaller probable error than at present, before we can expect to obtain from them much information on this subject. The hope of ultimately determining the constants and mode of operation of these forces is now one of the greatest inducements to the study of improvements in methods of observation both of the motions and physical phenomena of comets, and no efforts should be spared that may tend to further our progress in this path, now so clearly indicated to us.

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* *Astronomische Nachrichten*, No. 477, p. 352.

OBSERVATIONS OF VESTA AND CLIO,

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

BY MR. JAMES FERGUSON.

[Communicated by Lieutenant MAURY.]

[Corrected for refraction.]

VESTA.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	④ − * $\Delta\alpha$	④ − * $\Delta\delta$	④'s apparent α	④'s apparent δ	A.
1851.	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″	
June 18	11 39 57.6	6	B. A. C. 5771	+0 40.32	−14 43.21	17 0 18.20	−17 39 12.00	9
July 13	8 22.1	10	Lalande 30641	−0 25.77	−11 53.16	16 43 14.19	19 17 32.99	10
17	10 41 44.8	16	Lalande 30600	+0 3.08	− 0 57.57	16 42 14.55	19 35 25.33	10
20	11 29 45.3	10	"	−0 19.69	−14 51.92	16 41 51.76	19 49 20.13	10
Aug. 12	8 59 51.0	5	Lalande 30788	−0 1.18	− 6 30.60	16 48 49.26	21 38 29.44	9
13	9 14 8.5	16	"	+0 39.63	−11 23.46	16 49 30.06	21 43 22.39	10
14	9 43 2.8	11	"	+1 22.87	−16 14.08	16 50 13.29	21 48 13.11	9
15	10 39 1.3	3	"	+2 8.28	−21 10.75	16 50 58.69	−21 53 9.87	10

Adopted Mean Places, 1850.0, *of Comparison-Stars.*

*	Mag.	α	δ	Authority.
		h. m. s.	° ′ ″	
B. A. C. 5771	6	16 59 32.46	−17 24 25.70	British Association Catalogue.
Lalande 30641	8.9	16 43 34.48	19 5 34.78	Lalande's Catalogue.
" 30600	9	16 42 5.99	19 34 22.58	"
" 30788	8.9	16 48 45.09	−21 31 53.32	"

CLIO.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	⑫ − * Δα	⑫ − * Δδ	⑫'s apparent α	⑫'s apparent δ	A.
	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″	
1851, Nov. 28	16 46 29.2	3	B. A. C. 2806	+2 0.65	−11 59.41	8 17 49.15	+10 54 40.27	10
1852, Jan. 25	7 58 17.3	6	*a*	+0 8.78	− 6 19.72	7 33 6.68	21 38.27	8
26	7 44 9.5	6	*a*	−0 49.96	− 4 3.31	7 32 7.95	23 54.45	9
	8 42 58.0	10	*a*	−0 52.46	− 3 59.08	7 32 5.45	23 58.69	9
Feb. 3	7 51 54.1	6	Weisse XII. 756	+0 14.66	+ 0 27.80	7 24 46.35	44 24.86	8
	8 37 11.6	3	"	+0 12.64	+ 0 34.27	7 24 44.32	44 31.33	8
4	7 32 49.6	4	"	−0 35.46	+ 3 13.82	7 23 56.23	47 10.96	7
(1) 8	9 1 44.1	6	Weisse VII. 551	+2 31.93	+ 3 14.20	7 20 50.80	10 57 9.37	8
March 3	7 51 47.6	3	" 320	−0 32.80	+ 2 26.70	7 10 10.62	12 8 46.58	8
7	8 9 3.6	4	" 320	−0 48.19	+13 14.47	7 9 55.08	19 34.45	10
10	8 26 59.4	5	" 368	−2 29.41	+ 1 40.39	7 10 1.08	27 16.29	10
18	7 33 42.2	5	" 319	+0 39.66	+10 48.52	7 11 22.00	45 42.42	8
23	7 53 15.6	1	" 385	−0 1.50	−11 31.13	7 12 59.71	12 55 50.18	6
April 15	10 44 9.7	4	" 816	+0 42.86	+ 2 44.25	7 27 20.24	13 22 24.66	10
(1) 16	8 56 43.4	9	" 816	+1 29.59	+ 3 10.08	7 28 6.98	22 50.69	8
23	9 51 42.7	8	" 1053	+0 14.50	−11 50.11	7 34 25.21	23 22.63	10
24	9 46 38.9	4	" 1053	+1 11.26	−12 4.15	7 35 21.96	23 8.69	9
(2) 25	8 52 28.1	6	" 1053	+2 7.30	−12 16.89	7 36 17.99	22 56.67	8
27	8 19 56.9	6	Rümker 2282	−0 46.99	+11 26.77	7 38 20.92	+13 21 47.60	10

Adopted Mean Places, 1850.0, *of Comparison-Stars.*

*	Mag.	α	δ	Authority.	No. of Obs.
		h. m. s.	° ′ ″		
B. A. C. 2806	8	8 15 42.64	+11 6 41.92	Rümker's Catalogue.	
Weisse XII. 968	9	7 31 13.83	10 44 0.23	Weisse's Catalogue.	
a	9	32 50.79	10 28 18.87	α from Wash'n. Equat. ; δ from Mural.	4
Weisse XII. 756	9	24 24.56	10 44 16.51	Weisse's Catalogue.	
" 551	9	18 11.75	10 24 5.96	"	
" 320	9	10 36.39	12 6 37.06	"	
" 368	9	12 23.65	12 25 53.29	"	
" 387	9	12 54.55	13 7 38.32	"	
" 816	9	26 31.02	13 19 58.81	"	
" 1053	9	34 4.45	13 35 31.94	"	
Rümker 2282	9	7 39 1.71	+13 10 40.79	Rümker's Catalogue.	

(1) Observations doubtful ; the planet appearing too large.

(2) There is a fixed star of the 13th magnitude in this place, making the observations doubtful. This star was visible on the 27th, as well as several stars in the vicinity which were not visible on the 25th. It is therefore probable that the observation of the 25th was the planet. Through the whole of the series after February the planet was very faint, — of the (11.12) magnitude. In the aphelion it will be seen with difficulty, even in opposition.

ON THE ORIGIN OF THE FORMS AND THE PRESENT CONDITION OF SOME OF THE CLUSTERS OF STARS AND SEVERAL OF THE NEBULÆ.

By STEPHEN ALEXANDER,
PROFESSOR OF MATHEMATICS AND ASTRONOMY IN THE COLLEGE OF NEW JERSEY.

(*Concluded from page* 152.)

There are, however, some instances in which (in so far as has yet been ascertained) the separation of the two portions is complete; the distance between them being not inconsiderable in comparison with the size of either.

Of those represented in Sir John Herschel's plate of binuclear and double nebulæ (*Phil. Trans. for* 1833, Plate XV.), H. 1252, Fig. 68; H. 1146, Fig. 71; H. 2197, Fig. 73; H. 1905, Fig. 77; and H. 1358, Fig. 78, — all seem to exhibit features more or less consistent with the supposition that the ellipsoid may have been the primitive form: the last two appear as if seen quite obliquely. We cannot with equal plausibility assert as much with regard to the origin of H. 1408 or M. 60, Fig. 74 of the same plate.

The following, represented in the same plate, show more or less inequality in the condensations yet existing around the two nuclei; viz. H. 1202 or M. 61, Fig. 69, and H. 604, Fig. 70; as well as H. 3661 or M. 62, and H. 2487 (*Results of Observations, &c.*, Plate VI. Figs. 13 and 14, respectively). Of these, 3661 is pronounced to be "evidently a double globular cluster."[*]

In other instances, traces of a common origin are by no means so evident; for the symmetrical planes of the nebulæ seem to be placed at angles of not less than 60° with each other. Of this, the following are examples: H. 1414, H. 1397, and H. 936 (*Phil. Trans. for* 1833, Plate XV. Figs. 75, 76, and 79, respectively).

Now, though this is conceded, yet the examination of still more complex forms seems rather to render it supposable, that what have here been regarded as the primitive masses of the double nebulæ were themselves but derivatives from *masses of a higher order*. These derivatives or fragments may then have taken the form of an ellipsoid of temporary equilibrium, in much the same manner as it was assumed by the fragments of the spheroid of a lower order; or the great fragments may have been so projected, that their symmetrical planes or equators should be not far from perpendicular to one another; as we still find to be the apparent state of things in the instances of the nebulæ last specified.

"*Double nebulæ*, like double stars, may be either optically or physically double; but as we are here deprived, at least for the present, of the criterion of orbital motion," Sir John Herschel is disposed to include "under this head those cases only in which two nebulæ of the regular kind are so near each other as to mix their nebulosities."[†]

Something like an orbital motion must still subsist, if a binuclear or a double nebula be indeed a derivative of an ellipsoid, in the manner already supposed; the momentum of rotation of the ellipsoid being in no probable case wholly destroyed, in consequence of the rending and partial dispersion of its mass.[*]

2d. *Multiple Nebulæ.*

In H. 2859 (*Results of Observations, &c.*, Plate IV. Fig. 7) there seems to be some tendency to an elliptical outline, but without any central nucleus; but in place of it, there are four regions of special condensation symmetrically arranged near the edges. Two of the nuclei exhibit nearly equal condensations, and are larger than the others. The whole might seem to have some features in common with the binuclear nebulæ; with minor condensations in its primitive state, somewhat like those supposed by Sir William Herschel.[†]

One of the small nuclei in the nebula last described is itself *triple*. A division into at least *three* principal portions is also apparent in the very remarkable nebula represented in *Fig.* 33, which is from Mr. Mason's figure (*Transactions of the Amer. Phil. Society*, New Series, Vol. VII. Plate IIII.). It represents H. 1991.

The principal nebula has the appearance of a spheroid rent into three, if not more, principal portions, by the action of an internal force, which portions have again been subdivided. The curvature of the seeming fissures, with their general convexity *inward*, is consistent with such a supposition; while the greater condensation toward the center of the spheroid also appears, notwithstanding the division.[‡]

A nebulous band is visible, still connecting this nebula with the fainter one; which band is more distinctly visible in Sir John Herschel's figure (*Results of Observations, &c.*, Plate II. Fig. 2); and the "avenues" of the principal nebula are, in parts, more curved, but still in a direction consistent with the action of a repulsive force. The figure last referred to represents the nebula as seen with a larger telescope; but circumstances, explained by Sir John Herschel, prevented his making the drawing with all his usual accuracy, though the main features are well preserved: Mr. MASON's was completed with scrupulous care. There is a fine triple star in the situation represented in the figure, near to where the center of the primitive spheroid may be pointed out.*

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[*] *Results of Observations, &c.*, p. 23.

[†] *Ibid.*, p. 142.

[*] Sir William Herschel assigns various reasons for believing that the nebulosity of the two components of double nebulæ "originally belonged to one common stock." (*Phil. Trans. for* 1811, p. 286)

[†] *Phil. Trans. for* 1811, p. 319.

[‡] A division of a mass of this form and arrangement into *three* principal portions, by the action of an internal force, has about it a mechanical probability. It is in fact of frequent occurrence in the blasting of large bowlder-stones, as I have learned from my friend Professor John Torrey.

The fainter nebula has somewhat of the appearance of a broken ring, which had been overloaded toward one side. In SIR JOHN HERSCHEL's figure, the ring, if we may call it so, appears more perfect; and it has strange-looking appendages, as though portions had been ejected, both above and below the plane of the ring; and retaining in a measure their momentum of rotation, were both curved, in consequence, in the same general direction.

It seems supposable that the two nebulæ may have formed one mass: (an ellipsoid ? ?).

Near to this nebula is M. 8, H. 3722 (*Results of Observations, &c.*, Plate I. Fig. 1), which exhibits great complication; but has some general resemblance, on a large scale, to the fainter of the two individuals last described.

The more dense portion of the enormous and complex nebula about η *Argûs* (*Results of Observations, &c.*, Plate IX.), like the great nebula in *Orion*, exhibits some approximation to the form of the Greek Ω or broken ring in our *Fig.* 26; and "the great looped nebula," 30 (BODE) *Doradûs*, H. 2941 (*Results of Observations, &c.*, Plate II. Fig. 4), also shows traces like large spirals and broken rings.

Other large regions exhibit traces of connection; but, lastly, as seen "*entirely without telescopic aid*" the greater of the two Magellanic Clouds (*Results of Observations, &c.*, Plate VII. Fig. 2) "exhibits the appearance of an axis of light (very ill-defined indeed, and by no means strongly distinguished from the general mass) which seems to open out at its extremities into somewhat oval sweeps, recalling, in some faint degree, the appearance of that extraordinary object Mess. 27" (the spheroidal nebula or "dumb-bell" represented in *Figs.* 15 and 16). The smaller of the two Magellanic Clouds (*Results of Observations*, Plate VII. Fig. 1) delineated in the same way, has no little of a spheroidal look.

As seen in the telescope, however, SIR JOHN HERSCHEL says of the greater of the two, "All my own attempts to delineate other than very small portions of the Nubecula Major" "have been completely baffled by the overwhelming complexity of the details. The lesser cloud is less complex, — but for that very reason less interesting." †

It seems, therefore, to be no unreasonable conjecture, that the enormous masses, whether spheroids or rings, which (throughout the greater part of the whole investigation) have been designated as *primitive*, may themselves, as once before intimated, be *derivatives* of masses of a *higher order*, and perhaps of a *spheroidal* form.

The rotation of one of those masses might itself furnish the *projectile* force which scattered the ellipsoids of *the binuclear and double nebulæ*, after the great primary mass was rent; and urged onward the *cometic nebulæ*, as was implied in the description of them (Class V. Division 5th).

This inconceivably grand rotation would then be the most *ancient* of which we have any *visible* record; and the effects of it must probably still be in progress in the *systematic* proper motions of whole clusters, each as one body. Yet all conjecture would be vain as to the countless ages which must have elapsed during the vast developments of the primitive form; or at what remote period, between the first "beginning" and the "first day," the distribution of its truly immense, cluster-originating, but yet really fragmentary portions, itself first began.

It is difficult even to conceive of the vastness of these mere fragmentary portions, — of masses whose very *drops* are now *suns*, and the contractile force of whose exterior portions acting *at sensible depths* was no more than proportionate to the *molecular* action at the surfaces of bodies with which we are familiar.

It is, nevertheless, of great moment, that this very element of immensity should not be lost sight of, in our anticipation of the changes of these subordinate systems (the scattering of clusters) which may still be in progress. For, in comparison with the period of one rotation of a single cluster, any view which we have yet been able to obtain of that cluster's developments may be as truly momentary as are the glimpses of a revolving disc seen by a flash of electrical light in comparison with the time of the disc's whole rotation: no *angular* motion being visible in either case, but the system seemingly at rest; and, in the case of the cluster, at rest in the state it *was* centuries ago; viz. *about the time that its light now visible left the region in which the cluster then was.**

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* SIR JOHN HERSCHEL says of this nebula, that it "appears to have broken up into three portions by three rifts or cracks, extending from its center to its circumference, and whose directions meet at the double star."

He also remarks, — the nebula "belongs to the same class of objects as that in *Orion*, and the idea of an absorption by the double star in its middle is very forcibly suggested"; — and he adds, "This curious object has perhaps a proper motion." (*Mem. of Astronomical Society*, Vol. III. p. 63, col. of Remarks, and Vol. II. note to p. 490, respectively.)

† Quotations here are from the *Results of Observations, &c. at the Cape of Good Hope*, pp. 144, 147, and, again, 144, respectively.

Of H. 2878, which is situated in the greater of the two nubeculæ, SIR JOHN HERSCHEL says, that it "has very much resemblance to the Nubecula Major itself as seen with the naked eye"; and, in another description, "It would be strange, indeed, but not beyond the analogies of other wonderful disclosures effected by optical improvements, if instruments yet to be created, or even possibly those already in progress, should one day analyze this last-mentioned object into subordinate groups and systems of perhaps equal complexity." (*Results of Observations, &c.*, pp. 77 and 147, respectively.)

It may not here be wholly out of place to notice another seeming analogy; viz. that of the figures of such constellations as *Leo*, *Scorpio*, and *Corona Borealis* to those of the nebulæ represented in our *Figs.* 26, 27, and 28; as though the inferior developments and the rending of the fragments of our own cluster had been brought about by the action of forces, inferior perhaps, but yet analogous, to those which have combined to give the nebulæ here alluded to their existing forms.

* In view of these considerations we may also learn how large a scope

CONCLUSION.

From the continued dispersion of the individual stars, or of the systems of multiple stars of a cluster, combined with the (still existing) rotation, *new arrangements* may have resulted, as has been already, in some measure, intimated (p. 141) in the description of the binuclear nebula represented in *Fig.* 31. In this respect, moreover, the spiral represented in *Fig.* 6 would seem to have advanced farther than the other represented in *Fig.* 5; and some such effects may still be in progress.

Apart from these, however, *any* changes which the conglomerations of stars may undergo in the future, even the remote future, will be found to present a subject for investigation too inviting to be neglected, and too vast to be exhausted. Until some such changes can be traced, it were in vain to attempt to decide whether the hypothesis of a spheroidal origin of clusters and nebulæ is fully adequate in *measure;* although the preliminary discussion (p. 98) and the remarks introductory to the various classes may have established a reasonable probability that such is the fact: and even when such changes, if any, shall have been traced, the problem will present a complexity which can scarcely even be thought of with calmness.

Yet what has been specially asserted of the globular and elliptic forms may even now be extended to others: —

"That as regards a law and a structure, the induction which refers them as a class to the operation of similar causes, and assumes the prevalence within them of similar dynamical conditions, is most full and satisfactory. To abstain altogether from speculation as to what may be the nature of those causes and conditions, and to refuse all attempts to reconcile the phenomena of so large and so definite a class of cosmical existences with mechanical laws taken in their most general acceptation, would be to err on the side of excessive caution, and unphilosophical timidity. The time is clearly arrived for attempting to form some conception at least of the *possibility* of such a system being held in a state of permanent equilibrium, or of progressing through a series of regular and normal changes, resulting either in periodical restorations of a former state, or in some final consummation."[*]

In view of our hypothesis of the spheroidal origin of these "cosmical existences," a "consummation," though not a "final" one, has in most cases *long since* been reached; viz. when the dynamical equilibrium of the mass yielded to the accumulation of the destructive powers by which it was assailed.

While it is even to be expected that errors may hereafter be found in the various details which have been so fully exhibited, it is respectfully submitted whether this same hypothesis of the spheroidal origin of so many of the clusters and nebulæ, in its most important features, is not adequate in *mode;* or whether, in the very least, the phenomena do not even *require* the admission *a dynamical equilibrium destroyed*, as the one pervading principle, — guiding, as it would also seem, to the explanation of all the other conditions.

The more condensed clusters (other things being equal) must, upon this plan, be regarded as of probably the more recent origin; instead of being the older, as supposed by SIR WILLIAM HERSCHEL,[*] and if a continued dispersion is even yet in progress, the *permitted* catastrophes and collisions foreseen by that illustrious astronomer as consequences of "*the clustering power*"[†] will be the more frequently avoided; and stars, which like our sun have planets in their keeping, will bear their attendants away, beyond the reach of harm.

In view, then, of even the little that has yet been ascertained, may we not, in all humility, ask whether *this* was not indeed *the way* in which the SUPREME DISPOSER of both great and small events executed his vast purposes. It would seem not even to be inconsistent with a unity of design in the smallest, as well as the greatest transformations.

The growing leaf is fed by the exhalations which it finds in the atmosphere; and the leaf in its decay nourishes the vegetating tree; the roots of that tree are embedded in the *débris* of a comparatively ancient earth; the earth itself, in the view of the nebular hypothesis, has been detached from the sun; and the sun and other stars would now seem to be but the comparatively small fragments or drops of greater masses; which *were* themselves but fragments of masses of even a higher order: the one great plan, pervading the *whole*, being, BY MEANS OF A SEEMING DESTRUCTION, TO PROVIDE FOR A MORE PERFECT ADAPTATION AND DEVELOPMENT.

NOTE. — Since the description of Class V. Division 4th was in type, I have noticed that the star observed by MR. HIND in November, 1850, was seen by MR. J. F. JUL. SCHMIDT at Bonn, in January, 1850. It was then of the 6th magnitude and a most intensely red color. (See *Astronomische Nachrichten*, 760.)

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must be given to the meaning of such terms as *wellnigh simultaneous*, and others, as employed in the description of changes so vast: the first expletive, *wellnigh*, being possibly even out of place, as expressive of too great a duration, in the case of changes occupying so short an interval of time as a single century.

[*] SIR JOHN HERSCHEL, *Results of Observations, &c. at the Cape*, p 22.

[*] See *Phil. Trans. for* 1789, pp. 224 and 225.

[†] *Phil. Trans. for* 1785, p. 266. See also the remarks of SIR JOHN HERSCHEL with reference to such collisions, *Outlines of Astronomy*, (872).

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CRITERION FOR THE REJECTION OF DOUBTFUL OBSERVATIONS.

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1. In almost every true series of observations, some are found, which differ so much from the others as to indicate some abnormal source of error not contemplated in the theoretical discussions, and the introduction of which into the investigations can only serve, in the present state of science, to perplex and mislead the inquirer. Geometers have, therefore, been in the habit of rejecting those observations which appeared to them liable to unusual defects, although no exact criterion has been proposed to test and authorize such a procedure, and this delicate subject has been left to the arbitrary discretion of individual computers. The object of the present investigation is to produce an exact rule for the rejection of observations, which shall be legitimately derived from the fundamental principles of the Calculus of Probabilities.

2. *It is proposed to determine in a series of N observations, the limit of error, beyond which all observations involving so great an error may be rejected, provided there are as many as n such observations.*

The principle upon which it is proposed to solve this problem is, *that the proposed observations should be rejected when the probability of the system of errors obtained by retaining them is less than that of the system of errors obtained by their rejection multiplied by the probability of making so many, and no more, abnormal observations.*

In determining the probability of these two systems of errors, it must be carefully observed that, because observations are rejected in the second system, the corresponding observations of the first system must be regarded, not as being limited to their actual values, but only as surpassing the limit of rejection.

3. Let e be the base of the hyperbolic system of logarithms.

Let m be the number of unknown quantities.

Let N be the whole number of observations.

Let n be the number of observations proposed to be rejected.

Let $n' = N - n$ be the number of observations to be retained.

Let Δ, Δ', Δ'', &c. be the system of errors when no observation is rejected.

Let Δ_1, Δ_1', Δ_1'', &c. be the system of errors when n observations are rejected.

Let ε denote the mean error when no observation is rejected.

Let ε_1 denote the mean error when n observations are rejected.

Let $\varphi \Delta = \frac{1}{\varepsilon \sqrt{2\pi}} e^{-\frac{\Delta^2}{2\varepsilon^2}}$ denote the probability of an error Δ, in the first system, with the corresponding notation for the second system.

Let x be the ratio of the required limit of error for the rejection of n observations to the mean error ε.

Let $\psi x = \frac{2}{\sqrt{2\pi}} \int_x^\infty e^{-\frac{1}{2}x^2}$ be the probability of an error in the first system, which exceeds the required limit.

Let y be the probability, supposed to be unknown, of such an abnormal observation that it is rejected upon account of its magnitude.

Let $y' = 1 - y$ be the probability that an observation is not of the abnormal character which involves its rejection.

Let $\Sigma . \Delta^2 = (N - m)\, \varepsilon^2$ denote the sum of the squares of all the errors Δ, Δ', &c.

Let $\Sigma . \Delta_1^2 = (n' - m)\, \varepsilon_1^2$ denote the sum of the squares of all the errors Δ_1, Δ_1', &c.

4. The probability of the first system of errors embodying the condition that n observations exceed the limit $x\varepsilon$, is

$$P = \varphi \Delta . \varphi \Delta' . \varphi \Delta'' \dots \left(\frac{\psi x}{\varphi (x \varepsilon)}\right)^n = \frac{1}{\varepsilon^{n'} (2\pi)^{\frac{1}{2}n'}} e^{-\frac{\Sigma \Delta^2 - n x^2 \varepsilon^2}{2\varepsilon^2}} (\psi x)^n$$

$$= \frac{1}{\varepsilon^{n'} (2\pi)^{\frac{1}{2}n'}} e^{\frac{1}{2}(-N + m + n x^2)} (\psi x)^n.$$

The probability of the second system of errors is

$$P_1 = x'^{n'} x^n, \varphi \Delta_1 . \varphi \Delta_1' \dots = \frac{x'^{n'} x^n}{\varepsilon_1^{n'} (2\pi)^{\frac{1}{2}n'}} e^{-\frac{\Sigma \Delta_1^2}{2\varepsilon_1^2}}$$

$$= \frac{y'^{n'} y^n}{\varepsilon_1^{n'} 2\pi^{\frac{1}{2}n'}} e^{\frac{1}{2}(-n' + m)}.$$

5. To authorize the proposed rejection of n observations we must have

$$P < P_1$$

which gives at once

$$\left(\frac{\varepsilon_1}{\varepsilon}\right)^{n'} e^{\frac{1}{2}n(x^2-1)} (\psi\, x)^n < y'^{n'} y^n.$$

6. The value of y must be determined by the condition that P_1 is a maximum, and therefore that $y'^{n} y^n$ is a maximum. The differential of the logarithm of this equation gives then for the maximum

$$\frac{y'}{n'} = \frac{y}{n}$$

$$y = \frac{n}{N}, \quad y' = \frac{n'}{N}$$

$$y'^{n'} y^n = \frac{n^m\, n'^{n'}}{N^n}$$

which may be denoted by Q^N; and *the required condition of rejection becomes*, by extracting the Nth root,

$$\left(\frac{\varepsilon_1}{\varepsilon}\right)^{y'} \left(e^{\frac{1}{2}(x^2-1)}\, \psi\, x\right)^y < Q \qquad (A.)$$

in which

$$Q = y'^{\,y'} y^y = y^y\, (1-y)^{1-y}. \qquad (B.)$$

7. The relation of ε' to ε must depend upon the nature of the equations which correspond to the rejected observations. But in the form in which the problem is here presented, the attention is directed to no special case; and it is sufficient for a first approximation to suppose that the excess of $\Sigma \Delta^2$ over $\Sigma \Delta_1^2$ is only equal to the sum of the squares of the rejected observations, which gives the equation

$$(1-m')\, \varepsilon^2 - y\, x^2\, \varepsilon^2 = (y'-m')\, \varepsilon_1^2$$

in which $m' = \frac{m}{N}$.

Hence,

$$\frac{\varepsilon_1}{\varepsilon} = \left(\frac{1-m'-y\,x^2}{y'-m'}\right). \qquad (C.)$$

The combination of (A), (B), and (C) for various values of m' and y' gives a set of values of x, which will answer for most cases. Table I. contains such values for different values of m' and y.

8. When the attention is directed to the rejection of special observations, the values of ε' and ε can be determined by direct investigation, for which the usual forms of computation in the method of least squares afford various facilities; and the application of the criterion involved in (A) is simplified by means of Tables II. and III. Table II. contains Brigg. log. Q for different values of y, and Table III. contains Brigg. log. R for values of x, in which

$$R = e^{\frac{1}{2}(x^2-1)}\, \psi\, x. \qquad (D.)$$

Previously to the publication of these tables, computers will easily determine $\psi\, x$ from Bessel's table of $\int e^{-t^2}$, published in the *Fundamenta Astronomiæ*, or more conveniently from the tables given by Encke in his memoir, *Ueber die Methode der Kleinsten Quadrate*, in the *Berlin Jahrbuch* for 1834.

The slow rate at which R changes will be found greatly to facilitate the determination of the criterion, as will be seen in the following examples:—

Example 1. To determine the limit of rejection of a single observation in the case of thirty observations of the vertical semidiameter of *Venus*, made by Professor Coffin and Lieutenant Page with the mural-circle, at Washington, in the year 1846.

In the reduction of these observations, I have assumed two unknown quantities, of which one is a constant and the other is proportional to the horizontal parallax. I have then found for the residual errors

$-0''.63$	$+0''.27$	$+0''.60$	$+0''.30$	$-0''.10$	$-0''.19$
$+0.45$	-0.43	-0.17	-0.05	$+0.16$	-0.52
$+0.34$	$+0.08$	-0.23	-0.45	-0.47	-0.51
-0.26	-0.11	$+0.83$	$+0.11$	$+0.04$	-0.49
-0.28	$+0.13$	$+0.69$	$+0.45$	-0.12	$+0.50$

and I also find $\log.\ \varepsilon^2 = 9.2368.$

We have then, in this case,

$$N = 30, \qquad n = 1, \qquad n' = 29, \qquad m = 2$$

whence

$$\frac{\varepsilon'}{\varepsilon} = \left(\frac{28-x^2}{27}\right)^{\frac{1}{2}}, \quad Q^N = \frac{29^{29}}{30^{30}}$$

$$-N \log.\ Q = 1.9040.$$

For a first approximation let $\log.\ R = 9.3$

which gives $\log.\ R - N \log.\ Q = 1.2 < \left(\frac{\varepsilon}{\varepsilon'}\right)^{29}$

$$\begin{aligned} \log.\ \varepsilon^2 - \log.\ \varepsilon'^2 &> .08 \\ \log.\ (28-x^2) &< 1.35 \\ 28-x^2 &< 22.4 \\ x^2 &> 5.6 \\ x &> 2.4. \end{aligned}$$

If this value of the limit is substituted in the next approximation, we have $\log.\ R = 9.248$

whence

$$\begin{aligned} \log.\ \varepsilon^2 - \log.\ \varepsilon'^2 &> .0795 \\ x^2 &> 5.51 \\ x\,\varepsilon &> 0''.97 \end{aligned}$$

which is so much greater than either of the above errors of observation, that neither of them is to be rejected.

Example 2. To determine the limit of rejection of one or two observations in the case of fifteen observations of the vertical semidiameter of *Venus*, made by Lieutenant Herndon, with the meridian-circle at Washington, in the year 1846.

The same method of reduction used in this example as in the preceding gave for the residual errors

$-0''.30$	$+0''.48$	$+0''.63$	$-0''.22$	$+0''.18$
-0.44	-0.24	-0.13	-0.05	$+0.39$
$+1.01$	$+0.06$	-1.40	$+0.20$	$+0.10$

$$\log.\ \varepsilon^2 = 9.53050.$$

For the criterion of rejecting one observation, we have

$$N = 15, \qquad n = 1, \qquad n' = 14, \qquad m = 2$$

whence

$$\frac{\varepsilon'}{\varepsilon} = \left(\frac{13-x^2}{12}\right)^{\frac{1}{2}}, \quad Q^N = \frac{14^{14}}{15^{15}}$$

$$-N \log.\ Q = 1.5955.$$

For a first approximation let log. $R = 9.3$

which gives log. $R - N$ log. $Q = 0.90 < \left(\frac{\varepsilon}{\varepsilon'}\right)^{14}$

$$\begin{aligned} \log.\ \varepsilon^2 - \log.\ \varepsilon'^2 &> 0.13 \\ \log.\ (13 - x^2) &< 0.95 \\ 13 - x^2 &< 8.9 \\ x^2 &> 4.1 \\ x &> 2.0. \end{aligned}$$

If this value of the limit is substituted in the next approximation, we have

$$\log.\ R = 9.309$$

whence

$$\begin{aligned} \log.\ \varepsilon^2 - \log.\ \varepsilon'^2 &> 0.1292 \\ x^2 &> 4.083 \\ x\,\varepsilon &> 1''.18 \end{aligned}$$

which shows that the error $1''.40$ should be rejected.

For the criterion for rejecting two observations, we have

$N = 15, \quad m = 2, \quad n' = 13, \quad m = 2$

whence $\quad \frac{\varepsilon}{\varepsilon'} = \left(\frac{13 - 2\,x^2}{11}\right)^{\frac{1}{2}}, \quad Q^N = \frac{2^2 \,.\, 13^{13}}{15^{15}}$

$-\frac{N}{n}$ log. $Q = 1.2790.$

For a first approximation let log. $R = 9.3$

which gives log. $R - \frac{N}{n}$ log. $Q = 0.58 < \left(\frac{\varepsilon}{\varepsilon'}\right)^{6\frac{1}{2}}$

$$\begin{aligned} \log.\ \varepsilon^2 - \log.\ \varepsilon'^2 &> 0.18 \\ \log.\ (13 - 2\,x^2) &< 0.86 \\ 13 - 2\,x^2 &< 7.24 \\ x^2 &> 2.88 \\ x &> 1.7. \end{aligned}$$

If this value of the limit is adopted as a second approximation, we have $\quad$ log. $R = 9.360$

whence

$$\begin{aligned} \log.\ \varepsilon^2 - \log.\ \varepsilon'^2 &> 0.1882 \\ x^2 &> 2.930 \\ x\,\varepsilon &> 0''.997 \end{aligned}$$

which shows that the two observations corresponding to errors $+1''.01$ and $-1''.40$ should be rejected.

FIRST PART OF TABLE III. LOG. *R*.

Argument x	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
1.0	9.5015	9.4992	9.4970	9.4947	9.4924	9.4902	9.4880	9.4857	9.4835	9.4813
1	.4791	.4769	.4747	.4725	.4704	.4682	.4661	.4639	.4618	.4597
2	.4575	.4554	.4533	.4512	.4491	.4471	.4450	.4429	.4409	.4388
3	.4367	.4347	.4327	.4307	.4286	.4266	.4246	.4226	.4206	.4187
4	.4167	.4147	.4128	.4108	.4088	.4069	.4050	.4030	.4011	.3992
5	.3973	.3954	.3935	.3916	.3897	.3878	.3860	.3841	.3822	.3804
6	.3786	.3767	.3749	.3731	.3713	.3694	.3676	.3658	.3640	.3622
7	.3604	.3587	.3569	.3551	.3533	.3516	.3498	.3481	.3464	.3446
8	.3429	.3112	.3395	.3378	.3360	.3343	.3327	.3310	.3293	.3276
9	.3259	.3243	.3226	.3209	.3193	.3176	.3160	.3144	.3127	.3111
2.0	.3095	.3079	.3063	.3046	.3030	.3011	.2999	.2983	.2967	.2951
1	.2935	.2920	.2904	.2888	.2873	.2857	.2842	.2827	.2811	.2796
2	.2780	.2765	.2750	.2735	.2720	.2705	.2690	.2675	.2660	.2645
3	.2630	.2615	.2600	.2586	.2571	.2556	.2542	.2527	.2512	.2198
4	.2483	.2469	.2155	.2410	.2426	.2412	.2398	.2383	.2369	.2355
5	.2341	.2327	.2313	.2299	.2285	.2272	.2258	.2244	.2230	.2217
6	.2203	.2189	.2176	.2162	.2149	.2135	.2122	.2108	.2105	.2082
7	.2068	.2055	.2042	.2029	.2016	.2002	.1989	.1976	.1963	.1950
8	.1937	.1924	.1911	.1898	.1886	.1873	.1860	.1847	.1835	.1822
9	.1810	9.1797	9.1784	9.1772	9.1759	9.1747	9.1735	9.1722	9.1710	9.1697
3.0	9.1685									

FROM A LETTER OF PROFESSOR ARGELANDER TO THE EDITOR.

Bonn, 1852, *June* 25.

Herewith I send you an ephemeris of *Thetis* for July, — which will, I trust, represent the course of this planet with considerable accuracy. One of my pupils, Mr. Schoenfeld, has computed it from elements of his own, which I also communicate. After the moonshine *Thetis* will be too faint for observation by our telescopes here, and if we are to have any observations at all, they must be made at observatories provided with the great refractors, of which you have so many in America.

I have just sent you, by the way of Leipsic, the first part of my Southern Zones, together with auxiliary tables for the more convenient computation of the Declinations, — and hope that these tables will render the use of the new zone observations as convenient as that of others, in spite of the large changes in Declination so near the horizon. The second part will appear in the course of the present year, and will contain in the preface a full account of the manner in which the observations were instituted, and of their degree of accuracy. At present I will only remark that the probable error of a Right-ascension between —15° and —31° increases from $0^{s}.08$ to $0^{s}.12$; that of a Declination, from $1''.1$ to $1''.5$ or $1''.6$; so that it is in all cases very moderate.

FR. ARGELANDER.

ELEMENTS AND EPHEMERIS OF THETIS.

By E. SCHOENFELD.

Elements calculated from the Bilk observation of April 20, and the Bonn observations of May 21 and June 19.

Epoch 1852, June 0, $0^{h.}$ Berlin M. T.

$$\begin{array}{lrl} \left\{\begin{array}{l} L = \\ M = \end{array}\right. & \begin{array}{r} 214^{\circ}\ 32'\ 50''.98 \\ 315\ \ 19\ \ 32.99 \end{array} & \\ \pi & 259\ \ 13\ \ 17.99 & \text{Mean Equinox, June 0.} \\ \Omega & 125\ \ 26\ \ 25.15 & \\ i & 5\ \ 35\ \ 39.31 & \\ \phi & 7\ \ 31\ \ 10.52 & (e = 0.13086516) \\ \text{Log. } a & 0.3913184 & \\ \text{Log. } \mu & 2.9585289 & \mu = 908''.9268 \end{array}$$

For the middle observation, these elements give

Calc. — Obs.

$$\delta\lambda = -0''.11\ ; \quad \delta\beta = -0''.00.$$

The following ephemeris is calculated from the above elements: —

1852, $12^{h.}$ Berlin M. T.	App. α	Horary Motion.	App δ	Horary Motion.	Log. $\triangle$
	h. m. s.	s.	° ′ ″	″	
July 3	12 30 46.4	+2.90	+3 8 30	—23.8	0.322899
4	31 56.4	2.94	2 58 57	24.0	
5	33 7.3	2.97	49 19	24.1	
6	34 19.0	3.00	39 38	24.3	
7	35 31.5	3.04	29 52	24.5	0.331348
8	36 44.8	3.07	20 2	24.7	
9	37 58.9	3.10	10 9	24.8	
10	39 13.8	3.13	2 0 11	25.0	
11	40 29.4	3.17	1 50 10	25.1	0.339583
12	41 45.8	3.20	40 5	25.3	
13	43 3.0	3.23	29 57	25.4	
14	44 20.9	3.26	19 45	25.6	
15	45 39.6	3.29	1 9 30	25.7	0.347594
16	46 59.0	3.32	0 59 12	25.8	
17	48 19.1	3.35	48 51	26.0	
18	49 39.9	3.38	38 26	26.1	
19	51 1.4	3.41	27 59	26.2	0.355380
20	52 23.6	3.44	17 29	26.3	
21	53 46.4	3.47	+0 6 56	26.4	
22	55 10.0	3.49	—0 3 40	26.5	
23	12 56 34.2	+3.52	—0 14 18	—26.6	0.362935

OBSERVATIONS OF PSYCHE,

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By Mr. JAMES FERGUSON.

[Communicated by Lieutenant Maury.]

[Corrected for refraction.]

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	⑯ — *		⑯'s apparent		A.
				Δα	Δδ	α	δ	
1852.	h. m. s.			m. s	′ ″	h. m. s.	° ′ ″	
(1) May 6	11 50 16.1	4	Weisse IX. 1259	—3 22.39	+ 0 4.30	9 55 16.42	+13 30 9.16	10
7	8 14 30.1	9	Rümker 3061	—1 16.78	— 5 18.35	9 55 39.94	13 28 27.67	8
10	8 43 5.9	10	"	+0 8.11	—11 52.09	9 57 4.78	13 21 54.14	10
	9 45 26.2	4	"	+0 9.63	—11 56.83	9 57 6.30	13 21 49.40	10
13	9 21 42.6	14	*a*	+1 7.46	— 0 49.76	9 58 38.65	13 14 30.78	10
	10 17 13.3	5	"	+1 8.73	— 0 54.43	9 58 39.91	13 14 26.11	10
18	8 56 28.5	10	Rümker 3069	+1 12.40	+17 29.37	10 1 32.20	13 0 33.73	10
	9 13 48.7	4	*α Leonis*	+1 3.16	+19 14.10	10 1 32.33	13 0 33.10	10
20	8 31 13.8	6	"	+2 17.65	+13 6.29	10 2 46.80	12 54 25.48	10
		6	Weisse X. 45	—0 53.41	+ 8 35.42	10 2 46.62	12 54 27.51	10
24	8 29 55.4	9	"	+1 46.22	— 4 44.60	10 5 26.22	12 41 6.69	10
25	8 41 15.6	3	"	+2 28.43	— 8 16.34	10 6 8.41	12 37 35.01	10
31	9 26 38.6	11	Rümker 3113	+2 19.96	—12 21.43	10 10 36.01	12 12 49.46	10
June 9	9 18 37.3	3	Rümker 3172	+0 52.21	— 1 44.09	10 17 58.81	11 35 25.24	8
	10 16 4.8	3	"	+0 51.31	— 1 53.17	10 18 0.92	11 35 16.15	8
10	8 52 31.2	11	"	+1 43.51	— 6 19.83	10 18 50.09	11 30 49.54	8
11	9 17 42.0	5	"	+2 37.11	—11 7.99	10 19 43.69	11 26 0.31	10
	9 19 50.0	4	Weisse X. 316	+1 8.58	+10 41.01	10 19 43.75	11 26 3.15	10
12	9 12 48.9	4	"	+2 1.80	+ 5 52.76	10 20 36.97	11 21 14.99	8
15	8 42 48.8	8	Weisse X. 377	+1 48.62	+10 24.17	10 23 18.01	+11 6 31.19	8

Psyche was seen on the nights of the 13th of June and 2d of July, but on both nights other stars nearer the computed places were compared instead of it. It was looked for till the 10th of July, but the weather was unfavorable.

Adopted Mean Places, 1850.0, *of Comparison-Stars.*

*	Mag.	α	δ	Authority.	No. of Obs.
		h. m. s.	° ′ ″		
Weisse IX. 1259	8	9 58 32.19	+13 30 40.93	Weisse's Catalogue.	
Rümker 3061	8.9	9 56 50.10	13 31 21.59	Rümker's Catalogue.	
a	9	9 57 24.82	13 15 56.82	Washington Equatorial, from preceding.	14
Rümker 3069	7.8	10 0 13.33	12 43 40.11	Rümker's Catalogue.	
α Leonis	1	10 0 22.705	12 41 51.76	Washington Catalogue (1846).	
Weisse X. 45	8	10 3 33.58	12 46 26.93	Weisse's Catalogue.	
Rümker 3113	9	10 8 9.70	12 24 46.61	Rümker's Catalogue.	
" 3172	8.9	10 17 0.33	11 37 45.42	" "	
Weisse X. 316	7.8	10 18 28.93	11 15 58.45	Weisse's Catalogue.	
" 377	9	10 21 23.82	+11 17 31.49	" "	

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(1) In the first two observations, as published in the *Astronomical Journal*, No. 40, an error had been made in reducing the declinations, which is corrected here.

ZODIAC OF EGERIA.

By PROFESSOR J. S. HUBBARD.

Washington Observatory, 1852, *June* 16.

The inclosed Zodiac of *Egeria* is computed from my Elements III. given in No. 35 of this Journal. The planet can be seen in the northern limit only between January 10 and February 25, and in the southern only between July 13 and August 30.

α	δ		α	δ		α	δ	
	Northern Limit.	Southern Limit.		Northern Limit.	Southern Limit.		Northern Limit.	Southern Limit.
0°	—8° 16′	—23° 4′	120°	+46° 3′	+31° 54′	240°	—19° 3′	—36° 48′
5	4 28	19 26	125	45 33	31 21	245	21 33	38 54
10	—0 29	15 37	130	44 50	30 34	250	23 47	40 43
15	+3 39	11 43	135	43 51	29 32	255	25 43	42 16
20	7 50	7 46	140	42 45	28 14	260	27 23	43 31
25	12 0	—3 46	145	41 21	26 39	265	28 49	44 38
30	16 4	+0 11	150	39 43	24 48	270	29 59	45 28
35	19 59	4 0	155	37 51	22 40	275	30 54	46 5
40	23 40	7 40	160	35 42	20 13	280	31 35	46 29
45	27 4	11 7	165	33 16	17 26	285	32 1	46 42
50	30 11	14 20	170	30 34	14 21	290	32 13	46 42
55	32 58	17 17	175	27 34	10 57	295	32 12	46 29
60	35 28	19 58	180	24 17	7 16	300	31 56	46 4
65	37 40	22 22	185	20 46	+3 19	305	31 27	45 28
70	39 37	21 30	190	17 3	—0 50	310	30 43	44 42
75	41 15	26 21	195	13 10	5 7	315	29 44	43 44
80	42 38	27 56	200	9 11	9 25	320	28 29	42 31
85	43 48	29 16	205	5 11	13 39	325	26 59	41 2
90	44 44	30 22	210	+1 13	17 46	330	25 12	39 17
95	45 27	31 12	215	—2 39	21 40	335	23 7	37 16
100	45 58	31 48	220	6 24	25 19	340	20 45	34 58
105	46 17	32 11	225	9 56	28 41	345	18 4	32 23
110	46 24	32 19	230	13 14	31 44	350	15 6	29 32
115	46 20	32 13	235	16 16	34 27	355	11 49	26 26
120	+46 3	+31 54	240	—19 3	—36 48	360	—8 16	—23 4

Note. — In the Zodiac of *Parthenope* (*A. J.*, I. p. 151) the dates between which the planet can be in the northern limit should be April 4 and May 24, and in the southern, September 30 and November 18.

In the Zodiac of *Clio* (*A. J.*, I. p. 172) the dates for the northern limit should be July 18 and September 12, and for the southern, January 22 and March 16.

ELEMENTS OF PSYCHE.

Computed from observations made at Naples, March 17, Rome, April 15, and Hamburg, May 15.

Epoch, 1852, March 17.0, M. T. Greenwich.

M	196° 49′ 16″.10	
π	321 22 29.07	Mean Equinox of epoch.
☊	150 24 59.42	
ϕ	4 10 31.99	
i	2 59 24.20	
Log. a	0.4827990	
Log. μ	2.8258081	

For the middle place this orbit gives:

Calc. — Obs.

$$\delta\lambda = +0''.16\ ;\quad \delta\beta = 0''.00.$$

J. D. RUNKLE.

FIRST COMET OF 1852.

Dr. **Petersen** has kindly communicated the following additional information respecting this comet: —

Elements, — Computed by Mr. **Sonntag** from observations at Altona, May 17, Königsberg, May 24, and Vienna, June 5, — corrected for aberration and parallax.

T	April 19.61470 M. T. Berlin.	
π	280° 0′ 32″.6	Mean Equinox, May 17.5
☊	317 8 22.4	
i	48 52 53.5	
Log. q	9.9566628	
	Retrograde.	

These elements represent the observations as follows: —

	C. — O.
in Longitude	+10″.7
in Latitude	+ 8.5

This comet is therefore probably not identical with the second comet of 1827, — for this parabolic orbit, computed with a rigorous application of the small corrections dependent on the comet's distance, represents the observations too well to allow the probability of an ellipse of 25 years.

Observations. — 1. At Vienna.

1852.	M. T. Vienna. h. m. s.	App. α h. m. s.		Log. Par.	App. δ		Log. Par.	No. Comp.	Star.
June 5	11 3 57.5	10 58 0.53	—0.0169 $\Delta\delta$	9.053	+67° 35′ 34″.1	—0.014 $\Delta\alpha$	9.129	2	*a*
7	11 2 21.3	10 57 22.92	+0.0076 $\Delta\delta$	9.007	+64 43 21.5	+0.069 $\Delta\alpha$	9.278	3	*b*
8	10 53 23.7	10 57 13.09	—0.0008 $\Delta\delta$	8.984	+63 23 4.8	+0.011 $\Delta\alpha$	9.289	4	*c*, *d*

$\Delta\delta$ and $\Delta\alpha$ are the daily motion of the comet, expressed in minutes of arc. The comparison-stars are taken from the Catalogue compiled by W. **Oeltzen** from **Argelander**'s Zones, — and the first half of which is published in the Annals of the Vienna Academy (3d Series, Vol. I.). The star *b* was determined by comparisons with 11469 of this catalogue, to which also the numbers below refer.

The assumed mean places for 1852 of the comparison-stars are, —

		α h. m. s.	δ
a	11453	11 0 13.13	+68° 0′ 43″.0
b		11 3 0.58	+64 29 23.7
c	11470	11 0 40.00	+63 47 10.3
d	11395 11396	10 56 27.79	+63 24 52.9

2. At Königsberg by Dr. **Wichmann**.

1852.	M. T. Königsberg. h. m. s.	☄'s App. α	☄'s App. δ	Comp.-Star.	✱ App. α h. m. s.	✱ App. δ
May 21	12 31 31	333° 50′ 24″.3	+81° 45′ 56″.5	*a*	22 10 3.30	+81° 55′ 35″.3
23	12 19 12	322 47 27.3	+86 41 10.7	*c*	21 28 16.09	+86 24 37.7
24	12 30 50	284 56 57.5	+88 44 31.0	*d*	18 37 57.63	+88 42 57.0

The comparison-stars occur frequently in **Schwerd**'s observations of the circumpolar stars, and Dr. **Wichmann** has therefore deduced the following mean places for 1826.0.

			No. Threads.	α h. m. s.	δ
a	1826, October 23	N. 785	1	22 10 35.04	+81° 48′ 9″.0
	November 3	" 836	3	34.69	13.2
c	October 18	" 738	2	21 32 22.76	+86 18 2.8
	1827, " 14	" 1557	3	21.81	2.4
d	1826, August 2	" 564	2	19 0 49.76	+88 41 16.7
	" 16	" 611	1	46.30	14.9
	September 26	" 690	1	52.92	15.0
	" 28	" 706	1	50.15	14.7
	1827, July 18	" 1415	3	52.84	16.4

Hence, having regard to the number of threads observed, he obtained, —

	Mean Places for 1826. h. m. s		Mean Places for 1852. h. m. s.	
a	22 10 34.78	+81° 48′ 11″.1	22 10 2.51	+81° 55′ 54″.0
c	21 32 22.19	+86 18 2.6	21 28 10.01	+86 24 56.6
d	19 0 50.93	+88 41 15.5	18 37 9.67	+88 43 6.2

The star *c* is Groombridge 3548, and frequently observed in the last volume of the Radcliffe Observations.

NEW PLANET.

Mr. Hind informs me, under date of June 25, that during the previous night (June 24, 12h. 30m. Greenwich M. T.) he discovered a new planet, at Mr. Bishop's Observatory. He says: —

"It is a fine star of the 9 magnitude, and has a steady yellowish light. I can only send you a provisional place at present, the best star of comparison not being found in the Catalogues.

1852, June 24, 13h. 13m. 53s. Greenwich M. T.

App. R.A. of planet 18h. 12m. 58s..78 App. N. P. D. 98° 16′ 0″.9

The following are the differences between the planet and the small star above mentioned.

1852.	M. T Greenwich.	R A. Planet.	N. P. D. Planet.
	h. m. s.	s.	′ ″
June 24	12 41 22	∗ —24.10	∗ —4 53.4
	14 3 16	∗ —27.92	∗ —4 47.2

In a few days I hope we shall be able to send you better places."

Cambridge, 1852, *July* 10.

G.

FROM LETTERS OF DR. PETERSEN TO THE EDITOR.

Altona, 1852, *June* 20 *and July* 3.

The last comet was also discovered on the 7th of May, by Professor Schweizer in Moscow; but he had not time to convince himself that it was really a comet. On that evening the sky became clouded; on the 8th he went to St. Petersburg, and although he looked for the comet in Pulkowa, he could not succeed in finding it on account of the strong twilight. But it is at any rate very interesting, that this very feeble comet should also have been independently detected at four different places.

The following observations of the newest planet may be interesting to you.

1852.	M. T. Hamburg.	⑱ α	⑱ δ
	h. m. s.	° ′ ″	° ′ ″
June 28	12 7 31.8	272 12 59.1	—8 27 5.4
30	10 16 50.5	271 42 50.1	—8 33 26.8
	M. T. Berlin.	⑱ α	⑱ δ
	h. m. s.	° ′ ″	° ′ ″
June 29	11 35 13.2	271 57 44.3	—8 30 4.4
30	11 30 15.0	271 42 6.9	—8 33 30.4
	M. T. Altona.	⑱ α	⑱ δ
	h. m. s.	° ′ ″	° ′ ″
July 1	11 25 14.0	271 26 18.1	—8 37 8.8

The planet resembles a star of the 9 magnitude.

A. C. PETERSEN.

NOTICE.

The Editor of this Journal will be happy to receive subscriptions for the *Astronomische Nachrichten*, to be transmitted to Dr. Petersen at Altona. Under the new postal arrangements the *Nachrichten* may, after prepayment at Altona, be sent to this country by the American and English steamers from Liverpool, subject on delivery to the United States inland postage only. The price per volume current is, —

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G.

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ASTRONOMICAL OBSERVATIONS AT FRONTERA, TEXAS.

By BREVET MAJOR WM. H. EMORY, U. S. A.,
SURVEYOR AND PRINCIPAL ASTRONOMER OF THE MEXICAN BOUNDARY COMMISSION.

[By Authority of Hon. A. H. H. Stuart, Secretary of the Interior.]

The subjoined observations have been made for the determination of the geographical position of Frontera, on the Rio Bravo del Norte, about 15 seconds of time W. and 4′ 30″ N. of El Paso.

I. *For Determination of Longitude. Moon-Culminations observed at Frontera.*

Date.	Object.	Clock Time of Transit.		
1852.		h.	m.	s.
Jan. 1	α Piscium	2	18	58.65
	ξ Ceti	2	29	44.58
	Moon's I. L.	2	57	12.28
	845 B. A. C.	3	1	32.00
	π Arietis	3	5	38.22
3	η Tauri	4	3	26.04
	y Tauri	4	36	6.78
	Moon's I. L.	4	39	4 00
	ε Tauri	4	44	42.85
	α Tauri	4	52	10.23
4	ε Tauri	4	44	46.95
	α Tauri	4	52	11.16
	Moon's I. L.	5	35	8 22
	26 Aurigæ	5	53	56.57
	136 Tauri	6	8	50.08
5	ο Tauri	5	43	37.39
	ζ Tauri	5	53	40 11
	η Geminorum	6	30	19.32
	Moon's I. L.	6	31	36.52
	560 G. C. (1)	6	45	2.98
6	η Geminorum	6	30	53.21
	μ Geminorum	6	38	57.00
	560 G. C.	6	45	7 67
	Moon's II. L.	7	38	59.84
	κ Geminorum	8	0	27.45
7	δ Geminorum	7	36	16.73
	63 Geminorum	7	43	56 86
	κ Geminorum	8	0	30.35
	Moon's II. L.	8	41	51 70
	θ Cancri	8	48	9 30
	δ Cancri	9	1	15 88
Feb. 1	11 Orionis	5	22	59.09
	ζ Tauri	5	55	40.48
	Moon's I. L.	6	6	48.13
	η Geminorum	6	32	48.85
Feb. 2	ν Orionis	6	26	3.41
	η Geminorum	6	32	52.70
	μ Geminorum	6	40	56.10
	Moon's I. L.	7	7	13.63
	51 Geminorum	7	31	48.49
	δ Geminorum	7	38	12 96
4	β Geminorum	8	3	20.97
	φ Geminorum	8	11	31.88
	δ Cancri	9	3	22.43
	Moon's I. L.	9	13	33.48
	λ Leonis	9	50	22.90
5	δ Cancri	9	3	28.15
	792 G. C.	9	16	11.30
	λ Leonis	9	50	27.46
	847 G. C.	10	5	36 45
	Moon's II. L.	10	18	39.24
	α Leonis	10	27	40.84
	γ Leonis	10	39	0.32
7	n Leonis	11	35	28.79
	ι Leonis	11	43	34.13
	β Virginis	12	10	20.97
	Moon's II. L.	12	18	0.20
	η Virginis	12	39	41.94
9	δ Virginis	13	15	40.56
	θ Virginis	13	29	49.13
	ζ Virginis	13	54	41.00
	Moon's II. L.	14	10	38.72
	τ Virginis	14	21	38.54
	κ Virginis	14	32	31.92
	i Virginis	14	35	47.08
10	κ Virginis	14	32	36.37
	1135 G. C.	14	35	51.51
	λ Virginis	14	38	42.48
	Moon's II. L.	15	6	15.81
	α^2 Libræ	15	10	17.68
Feb. 10	ξ^2 Libræ	15	16	20.41
	1210 G. C.	15	20	39.97
	β Libræ	15	36	38 73
11	1264 G. C.	15	54	55.39
	Moon's II. L.	16	2	23.81
	θ Libræ	16	13	4.52
28	417 G. C.	5	23	9.36
	Moon's I. L.	5	42	36.01
	ο Tauri	5	47	39.24
	462 G. C.	5	52	26.59
	ζ Tauri	5	57	42.54
29	ζ Tauri	5	57	46.71
	535 G. C.	6	34	55.70
	Moon's I. L.	6	39	59.64
	μ Geminorum	6	42	59.45
	γ Geminorum	6	58	8.76
Mar. 1	μ Geminorum	6	43	3.75
	γ Geminorum	6	58	13.48
	626 G. C.	7	24	23.65
	51 Geminorum	7	33	56.19
	Moon's I. L.	7	40	18.01
	673 G. C.	7	48	1.29
2	673 G. C.	7	48	5.31
	685 G. C.	8	0	3.94
	694 G. C.	8	6	41.56
	Moon's I. L.	8	42	28.24
	758 G. C.	8	52	18.01
	769 G. C.	9	0	41 29
	δ Cancri	9	5	25.02
3	θ Cancri	8	52	23.71
	δ Cancri	9	5	30.90
	α Cancri	9	19	37.98
	815 G. C.	9	39	57.82
	Moon's I. L.	9	45	11.31
	ξ Leonis	9	53	13.05

(1) Greenwich Twelve-Year Catalogue.

Date.	Object.	Clock Time of Transit.	Date.	Object.	Clock Time of Transit.	Date.	Object.	Clock Time of Transit.
1852.		h. m. s.	1852.		h. m. s.	1852.		h. m. s.
Mar. 3	*o* Leonis	10 2 30.37	Mar. 8	*p* Virginis	14 16 45.28	Apr. 2	Moon's I. L.	12 17 19.77
4	*o* Leonis	10 2 34.15		*i* Virginis	14 37 51.33		*π* Virginis	12 24 58.28
	α Leonis	10 29 48.72		*λ* Virginis	14 40 45.30	4	*δ* Virginis	13 20 1.79
	37 Leonis	10 38 3.40		Moon's II. L.	14 45 9.33		1075 G. C.	13 59 2.27
	Moon's I. L.	10 47 10.69		*μ* Virginis	15 4 51.74		Moon's II. L.	14 17 14.24
	896 G. C.	10 51 20.46		*α*² Libræ	15 12 20.64		*κ* Virginis	14 36 53.19
5	37 Leonis	10 38 8.99	Apr. 1	*γ* Leonis	10 43 23.73	5	*λ* Virginis	14 43 5.01
	896 G. C.	10 51 26.17		Moon's I. L.	11 18 3.97		*μ* Virginis	15 7 14.14
	Moon's I. L.	11 47 47.99		*χ* Leonis	11 28 58.07		Moon's II. L.	15 16 34.66
	Moon's II. L.	11 50 8.75		*δ* Leonis	11 37 49.27	6	*β* Libræ	15 41 7.41
	ν Virginis	12 7 10.80		*i* Leonis	11 47 47.82		*ζ* Libræ	15 51 59.65
	π Virginis	12 22 12.74	2	*χ* Leonis	11 29 3.51		Moon's II. L.	16 16 51.74
6	*ν* Virginis	12 7 13.78		*δ* Leonis	11 37 51.89		*β* Scorpii	16 28 51.82
	Moon's II. L.	12 49 15.27		*i* Leonis	11 47 53.23		*γ* Scorpii	16 35 28.48
	y Virginis	13 3 38.43						

From the above observations is deduced, assuming the tabular places of the moon as correct, the longitude of Frontera,—

$7^{h.}\ 5^{m.}\ 56^{s.}.81$

Occultations.

		Sidereal Time. h. m. s.	Observer.
1852, Jan. 6	Immersion of *δ* Geminorum	5 32 14.3	Emory.
	Emersion of *δ* Geminorum	6 57 51 2?	"
Feb. 28	Immersion of (*o* Tauri ?)	5 52 55.8	"
		M. Solar Time.	
March 1	Emersion of *δ* Geminorum	8 30 21.18	Gardner.
March 26	Immersion of Anonyma	6 5 48.29	"
	Emersion of Anonyma	8 28 32.69 ?	"

II. *Determination of Latitude by Observations with Zenith-Telescope.*

Seconds of Latitude.

No. of Star in B. A. C.		March 23.	March 24.	March 25.	March 26.	March 27.	March 28.	March 30.
N.	S.							
2504	2469		40.66			40.26		
2691	2605		43.20				45.27	43.40
2798	2788	48.02	48.13	49.02	48.59		45.65	44.81
2855	2818	45.71	43.63	43.97	44.00	44.05	42.00	42.52
2912	2952	49.79	46.74	48.90	46.53	49.24	47.63	44.11
3033	3109	45.74			46.60	44.27	45 23	43.10
3131	3181			44.19	42.88	43.68	43.24	39.77
3252	3201	43.84		43.02	45.37	43.72		45.00
3261	3201			42.72	43.50			43.04
3399	3355	46.82		45.60	45.62			44.85
3427	3409			48.32	46.22			46.39
3584	3671	42.95		42.78	43.43	44.36		42.64
3736	3710			39.08	44.50	44 65		39.46
3842	3781			42.64	43.79	42.56		43.92
3973	3990			47.35	44.15	47.11		43.14
4026	4014	45.33			46.02			46.31
4028	4011	45.00			45.83			46.93
4126	4066							48.97
4188	4111							42.50
4258	4212							39.28
Mean for each night,		44.06	44.17	44.54	44.83	44.09	44.83	44.20

Adopted Latitude = 31° 18′ 44″.43.

ASTRONOMICAL OBSERVATIONS AT THE OBSERVATORY OF CHRISTIANIA, NORWAY.

By PROFESSOR CHRISTIAN HANSTEEN,
DIRECTOR OF THE OBSERVATORY.

[Communicated by the Smithsonian Institution.]

NEPTUNE.

1851.	M T. Christiania.	α	δ	Δα	Δδ
	h. m. s.	h. m. s.	° ′ ″	″	″
Dec. 2	5 50 38.56	22 34 24.75	—9 54 10.19 ::	+2.54	+7.71
24	4 25 18.57	35 35.02		—0.75	
25	4 21 27.45	35 39.83	—9 46 25.30	+3.00	+2.51
28	4 9 53.65	22 35 53.80 :		—2.25	

With a 3-foot meridian-circle by Ertel, Munich. The planet was extremely faint and difficult to see. Δα, Δδ are the differences, Observation — Ephemeris (Vogel, Berlin *Astron. Jahrb.*, 1853, according to Walker's Elements), both in seconds of arc.

URANUS.

Date.	M. T. Christiania.	α	δ	Δα	Δδ	Mean Δα	Mean Δδ	
	h. m. s	h. m. s.	° ′ ″	″	″	″	″	
1851, Oct. 27	11 38 25.8	2 1 13.17	+11 47 1.46	—163.95	—54.95			The ordinary transits are over 7 threads.
Nov. 10	10 42 13.3	1 59 3.12	35 25.92	168.30	56.33			
15	20 50.1	58 19.19	31 36.77	168.90	58.34			
17	12 41.5	58 2.41	30 8.71	165.00	56.50			
20	10 0 28.4	57 37.40	27 55.44	167.10	58.41	—166.65	—56.91	
Dec. 1	9 15 51.5	56 14.85	20 41.29	165.90	58.41			
2	11 48.6	56 7.81	20 3.47 ::	169.50	67.00 ::			Storm.
4	9 3 48.7	55 54.74	18 57.26	168.30	58.42			
19	8 3 27.1	54 36.60 :		163.80				Very dusky.
23	7 47 29.1	54 22.15	11 1.59	164.40	60.74	—166.38	—59.15	
24	43 30.1	54 19.15	10 48.12	162.00	58.97			
25	39 31.2	54 16.13	10 34.43	163.20	58.42			
26	35 32.6	54 13.37	10 18.97	163.05	60.71			
30	19 39.9	54 4.28	9 40.26	162.75	57.42			
31	15 42.4	54 2.72	9 33.85	158.40	55.94	—161.88	—58.29	
1852, Jan. 1	11 44.7	54 0.96	9 27.71	160.50	55.25			
3	7 3 50.1	53 58.23	9 14.77	162.00	58.00			
13	6 21 32.7	53 59.88 ::	9 27.20		59.40			A.R. very doubtful.
19	6 1 2.65	54 5.41 ::	10 29.85	165.60 ::	57.49			
26	5 33 51.1	54 25.21	12 30.23	157.20	57.53	—161.32	—57.53	
31	5 14 30.4	54 44.86	14 32.69	156.30	52.85			
Feb. 5	4 55 15.6	1 55 8.94	+11 16 53.13	—160.95	—55.73	—158.63	—54.29	

Δα, Δδ = Observation — Ephemeris (Berlin *Astron. Jahrb.*). The error in α is diminishing from the opposition to the quadrature, as already remarked by Mr. Airy, as a consequence of an error in the radius-vector.

MERCURY.

1852.	M T. Christiania.	α	δ	Δα	Δδ	Mean Δα	Mean Δδ
	h. m. s	h. m. s	° ′ ″	″	″	″	″
April 4	1 18 14.7	2 0 7.62	14 22 47.5	—2.5	—0.2		
6	1 10 38.1	2 10 24.38	15 36 40.3	—0.3	—4.6	—0.67	—2.37
8	1 11 47.4	2 19 27.36	16 39 25.4	+1.8	—2.3		

SATURN.

Date.	M. T Christiania.	α	δ	Δα	Δδ	Mean		
						Δα	Δδ	
	h. m. s.	h. m. s.	° ′ ″	″	″	″	″	
1851, Oct. 30	11 23 11.8	1 56 55.27	+9 1 14.39	+16.95	—6.95			
Nov. 11	10 31 40.1	53 21.77	8 42 2.09	18.00	8.85			
14	19 3.0	52 35.32	38 55.89	21.90	6.80			
15	11 51.0	52 19.19		18.00				
17	10 6 28.1	51 48.00	31 58.71	21.90	8.55	+19.95	—7.79	
20	9 53 54.5	51 1.93	31 17.33	14.85	8.15			
Dec. 1	8 13.8	48 35.85	20 1.70	17.85	6.69			
2	9 1 6.4	48 24.45	19 10.01	18.45	8.69			
4	8 55 52.6	48 2.33	17 31.19	16.80	6.86			
6	47 40.5	47 41.98	16 13.56	17.40	6.25	+17.09	—7.33	
9	35 21.6	47 13.78	14 20.77	15.75	9.60			
14	8 15 6.6	46 34.24	12 3.35	16.65	8.18			
19	7 54 56.6	46 4.60::	10 36.60::	16.98	13.34			Planet observed as of a pale green color through a misty cloud of icy particles.
23	38 56.5	45 48.19	10 20.43	17.25	9.29			
24	35 57.4	45 45.04	10 23.51	16.50	6.96	+16.63	—9.47	
25	30 58.8	45 42.29	10 26.17	15.60	8.38			
26	27 0.7	45 40.09	10 28.84	16.69	6.64			
30	11 12.2	45 35.27	11 19.18	17.40	7.12			
31	7 16.6	45 ——	11 35.53		9.63			
1852, Jan. 1	7 3 20.6	45 35.41	11 55.59	19.20	8.82	+17.22	—8.12	
3	6 55 30.2	45 36.93	12 42.69	15.15	9.50			
13	6 16 47.8	46 13.71						
19	5 53 48.9	46 50.46::	24 42.69	8.25::	9.66			Clock-correction not quite certain.
31	5 8 41.3	1 48 51.06	+8 39 53.66	+16.35	—7.34	+15.75	—8.83	

MARS.

1852.	M. T. Christiania.	α	δ	Δα	Δδ	Mean		
						Δα	Δδ	
	h. m. s	h. m s	° ′ ″	″	″	″	″	
March 4	8 57 51.6	7 48 51.31	24 49 15.3	+12.2	—11.9			
7	46 20.0	49 4.46	42 37.2	15.3	6.1			Air very unquiet.
8	42 34.5	49 14.93	40 3.2	16.3	10.5			
9	38 51.8	49 28.13	37 27.5	13.7	8.9	+15.38	—9.35	
14	21 1.5	51 17.67	22 34.2	13.5	9.3			
16	14 12.4	52 20.53	15 51.2	13.8	7.6			
19	4 17.5	54 13.63	4 55.5	8.3	6.6			
20	8 1 4.3	54 56.83	24 1 4.4	15.1	4.9	+12.68	—7.10	
21	7 57 53.5	55 44.72:	23 57 3.3	12.3	8.0			Transit over 2 threads.
24	48 34.5	58 10.86	41 33.0	11.4	5.7			
25	45 32.5	7 59 4.93	40 12.3	13.1	3.4			Transit over 5 threads.
26	42 32.5	8 0 0.93	35 38.5	12.5	7.8	+12.32	—6.22	
28	36 38.9	1 59.49	26 25.0	17.3	4.1			
29	33 45.1	3 1.79	21 32.3	11.6	9.0			
30	30 53.0	4 5.84	16 38.7	11.1	8.9			
31	28 5.9	5 14.73	11 43.3	10.2	4.2	+12.55	—6.55	
April 1	25 14.6	6 19.76	23 6 39.1	11.7	2.4			
3	19 43.0	8 40.09	22 56 2.0	4.1	9.3			
4	16 59.7	9 52.96	50 43.2	11.1	4.0			
5	14 18.0	11 7.32	45 11.2	10.1	5.6	+9.25	—5.32	
6	11 37.7	12 23.16	39 35.2	7.7	4.6			
7	7 8 59.3	13 40.91	22 33 56.2	11.4	1.5			
15	6 48 10.7	24 51.37	21 44 29.2	10.2	—5.5			
17	43 48.8	27 51.75	31 12.8	9.2	+0.4	+9.62	—2.80	
18	41 21.6	29 23.78	24 17.2	10.1	—3.0			
19	6 39 1.4	8 30 56.67	21 17 16.0	+ 7.2	—6.8	+8.65	—1.90	

VENUS.

1852.	M. T. Christiania.	α	δ	$\Delta\alpha$	$\Delta\delta$	Mean $\Delta\alpha$	Mean $\Delta\delta$	
	h. m. s.	h. m. s.	° ′ ″	″	″	″	″	
March 19	2 33 56.2	2 52 58.10	15 10 51.3	—5.3	—9.9			
20	34 30.5	27 29.57	15 36 55.7	9.3	9.5			
21	35 6.4	32 1.57	16 2 36.8	6.2	10.7			
24	36 56.7	45 41.74	17 17 27.1	6.3	10.3	—6.75	—10.10	
26	38 13.2	2 54 51.70	18 5 18.1	7.2	11.2			
29	40 13.3	3 8 41.71	19 13 54.4	5.7	8.7			
30	40 51.4	13 19.51	19 35 52.4	7.7	7.8			
31	41 36.3	17 58.12	19 57 19.9	4.1	8.2	—6.15	—8.98	
April 1	42 18.8	22 37.27 :	20 18 16.8	2.6	10.8			5 threads.
3	43 43.9		20 58 44.8					
4	44 29.1	37 20.47	21 18 20.1	6.8	7.0			
5	45 13.6	41 18.72	21 37 16.9	7.0	8.7	—5.47	—8.83	
6	45 58.7	46 0.55 :	21 55 43.3	3.9	9.2			Great tremor.
8	47 30.0	3 55 25.21	22 31 4.4	6.5	4.4			
14	52 12.1	4 23 47.37	24 3 25.5	8.1	8.3			
18	2 55 23.3	4 42 45.35	24 53 20.0	—7.8	—4.2	—6.58	—6.53	

Occultation of Fixed Stars.

I observed up stairs, with the 5-foot equatorial by Repsold, and a box-chronometer, No. 1259, by Kessels, on the 28th March with a magnifying power of 165, on the 30th March with a power of 57.

The janitor of the Observatory, Throndsen, below stairs, with a box-chronometer by Kessels, No. 1390, and the 28th March with a 6-foot Munich achromatic, the 30th with a 3-foot Fraunhofer and a lower power.

1852, *March* 28, *Occultation of* 36 d *Geminorum.*

1259.	Hansteen Corr. Chron.		M. T. Christiania.	1390.	Throndsen Corr. Chron.		M. T. Christiania.	Difference T. — H.
h. m. s.	s.		h. m. s.	h. m. s.	m. s.		h. m. s.	s.
12 46 19.5	—51.26	=	12 45 28.24	1 11 26.0	—25 57.51	=	12 45 28.49	+0.25

1852, *March* 30, *Occultation of* 11 *Stars in Cancer.*

	1259.	Correction.		M. T. Christiania.	1390.	Correction.		M. T. Christiania.		Difference T. — H.
	h. m. s.	s.		h. m. s.	h. m. s.	m. s.		h m. s.		s.
1	9 3 32.0	—53.93	=	9 2 38.07						
2	19 53.5	—53.93	=	18 59.57					38 (*o*) *Cancri*	
3	33 31.2	—53.94	=	32 40.26	9 58 49.0	—26 8.13	=	9 32 40.87	124 *Cancri*	+0.61
4	34 55.0	—53.94	=	34 1.06						
5	36 33.2	—53.94	=	35 29.26	10 1 38.0	—26 8.14	=	35 29.86		+0.60
6	39 38.0	—53.94	=	38 41.06	4 53.0	—26 8.15	=	38 41.85		+0.79
7	40 32.8	—53.94	=	39 38.86	5 47.0	—26 8.15	=	39 38.85		—0.01
8	45 56.5	—53.95	=	45 2.65	11 11.5	—26 8.17	=	45 3.33		+0.68
9	48 45.3	—53.95	=	47 51.35	13 59.8	—26 8.18	=	47 51.62	41 (*ε*) *Cancri* (?)	+0.27
10	50 missed		=	50	10 16 49.4	—26 8.18	=	9 50 41.22	121 *Cancri* (?)	
11	9 57 46.5	—53.95	=	9 58 52.55						

The two chronometers were, before and after the observations, compared with the transit-clock of Kessels by coincidences, and their rate was perfectly known. The good correspondence between the reduced mean time of the two observers shows that no considerable error is committed. The mean difference T. — H. is = +0ˢ.46. Throndsen always observes transits 0ˢ.4 to 0ˢ.44 later than I; perhaps in consequence of a personal equation; or perhaps he has sometimes taken a half-second for a whole, as the chronometers beat half-seconds.

The Longitude of Christiania is 0ʰ· 33ᵐ· 33ˢ.3 East of Paris.
Latitude " " 59° 54′ 43″.7.

OBSERVATIONS OF THE FIRST COMET OF 1852,

MADE AT THE OBSERVATORY OF HARVARD COLLEGE, CAMBRIDGE.

[Not corrected for parallax.]

1852.	Cambridge M. S. T. h. m. s.	Δα ☄—* m. s.	No. of Obs.	Δδ ☄—* ′ ″	No. of Obs.	Star of Comp.	App. α h. m. s.	App. δ ° ′ ″
May 18	13 0 57.6	— 0 19.72	5	—1 5.3	5	*a*	22 28 56.51	+74 35 1.3
18	13 10 32.6	— 0 24.55	6	+3 53.5	6	*b*	22 28 54.32	74 36 45.9
18	14 2 22.0	— 0 30.50	2	+9 23.2	2	*b*	22 28 48.37	74 42 15.6
19	9 36 10.0	— 1 12.18	9	+3 52.1	9	*c*	22 26 12.38	76 52 56.0
20	9 37 18.0	— 2 23.57	6	+4 5.7	6	*d*	22 21 38.78	79 31 28.6
21	9 11 35.4	+ 1 59.30	6	+1 41.4	6	*e*	*+1 59.30	*+1 44.4
21	11 14 37.3	+10 11.40	6	+7 50.5	5	*f*	22 13 31.47	82 16 53.7
22	9 4 30.5	— 0 31.27	6	+1 29.3	6	*g*	*—0 31.27	*+1 29.3
25	10 38 12.6	—10 12.53	4	—4 45.2	7	*h*	*—10 12.53	*—4 45.2
June 5	9 24 18.5	+ 0 9.91	6	—2 50.9	6	*i*	10 57 56.98	67 19 52.6
14	10 26 49.4	+ 0 24.15	1	—4 18.4	2	*k*	10 57 12.38	+56 10 4.8

Stars of Comparison referred to the Mean Equinox of January 1*st*, 1852.

Star.	α h. m. s.	δ ° ′ ″	Mag.	Authority.
a	22 29 16.42	+74 36 25.8	9	The places of *a* and *b* have been derived from
b	22 29 18.87	74 32 52.4	10	comparison with B. A. C. 7907.
c	22 27 24.65	76 49 23.1	9	Gr. 3821; Radcliffe Observation.
d	22 24 2.42	79 27 42.1	11	By comparison with the star *d′*.
d′	22 31 6.55	79 24 50.1	9	Arg. Zone 45, No. 109.
e	22 12 18	82 1 50	11	Approximate place.
f	22 3 18.97	82 9 22.2	7	B. A. C. 7732.
g	22 0 23	84 32 42	11	Approximate place.
h	12 43 5	87 45 40	9.10	" "
i	10 57 47.19	67 22 27.6	9.10	Arg. Zone 176, No. 116.
k	10 56 48.06	+56 14 9.5	9.10	" 92, No. 112.

The comet was very faint on the 14th, and the observed place was taken with difficulty and some uncertainty, particularly in right-ascension.

WILLIAM C. BOND.

OBSERVATIONS OF JUPITER,

MADE WITH THE MERIDIAN-CIRCLE OF THE ALTONA OBSERVATORY.

BY A. SONNTAG.

[Communicated by Dr. PETERSEN.]

The Declinations are corrected for parallax.

1852.	M. T. Altona. h. m. s.	α h. m. s.	Half Time of Transit. s.	δ ° ′ ″
May 11	11 43 46	15 3 16.36	1.65	—15 59 32.9
15	11 26 2	15 1 14.95	1.60	15 51 29.1
16	11 21 36	15 0 44.97	1.63	15 49 32.6
18	11 12 45	14 59 45.54	1.61	15 45 38.0
19	11 8 19	14 59 15.93	1.60	—15 43 37.6

EIGHTEENTH ASTEROID.

Melpomene has been observed by Mr. **Ferguson** at Washington, on the 28th and 29th July. Lieutenant **Maury** communicates the observations as follows: —

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	⑱ — ∗ Δα	⑱ — ∗ Δδ	⑱'s apparent α	⑱'s apparent δ
1852.	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″
July 27	10 53 9.8	16	B. A. C. 6049	—0 52.15	—10 28.57	17 43 59.96	—11 2 1.84
	11 44 51.5	5	"	0 53.24	10 44.02	43 58.56	2 17.69
28	8 50 21.3	5	"	1 18.77	16 50.57	43 33.40	8 23.79
	9 18 38.6	10	"	1 19.47	16 58.30	43 32.71	8 31.54
	9 45 33.6	5	"	—1 20.16	—17 6.84	17 43 32.01	—11 8 40.08

Adopted Mean Place, 1850.0, *of Comparison-Star.*

∗	α	δ
	h. m. s.	° ′ ″
B. A. C. 6049	17 44 43.60	—10 51 33.75

The planet is of the 9.10 magnitude.

FROM A LETTER OF DR. PETERSEN TO THE EDITOR.

Altona, 1852, *July* 13.

I inclose you some observations of *Melpomene*, as **Airy** has named Mr. **Hind**'s new planet, at Mr. **Bishop**'s request.

1. At Altona, with the meridian-circle.

1852.	M. T. Altona.	⑱ α	⑱ δ
	h. m. s.	° ′ ″	° ′ ″
July 1	11 25 11	271 26 18.2	—8 37 8.6
2	11 20 17	271 10 47.4	40 51.3
3	11 15 20	270 55 26.2	44 43.5
4	11 10 23	270 40 9.7	48 46.9
5	11 5 26	270 21 57.1	8 53 1.0
7	10 55 36	269 55 12.7	9 1 57.3
8	10 50 41	269 40 33.4	6 38.0
11	10 36 4	268 58 0.6	21 37.9
12	10 31 14	268 44 27.9	—9 26 52.5

Moreover, Mr. **Sonntag** finds the mean place for 1852.0 of the comparison-star used by **Hind**, June 24, to be, by three meridian observations,

α	δ
h. m. s.	° ′ ″
18 13 22.67	—8 20 41.8

And according to this the place of the planet as determined by Mr. **Hind**'s observations,

1852.	M. T. Greenwich.	α	δ
	h. m. s.	h. m. s.	° ′ ″
June 24	12 41 22	18 13 0.41	—8 15 46.0
	14 3 16	18 12 56.59	—8 15 52.2

2. At Göttingen, the right-ascensions observed by Dr. **Westphal** with the transit-instrument, — the declinations by Mr. **Klinkerfues** with the meridian-circle.

1852.	M. T. Göttingen.	⑱ α	⑱ δ
	h. m. s.	h. m. s.	° ′ ″
July 4	11 10 22.2	18 2 40.87	
5	11 5 25.8	18 1 40.27	8 53 13.1
6	11 0 30.2	18 0 40.37	8 57 27.6
7	10 55 35.2	17 59 41.05	9 2 5.2

3. At Vienna, by Mr. **Hornstein** with the refractor.

1852.	M. T. Vienna.	α	δ
	h. m. s.	h. m. s.	° ′ ″
July 3	10 15 17.1	18 3 45.82	—8 44 25.7

The mean place for 1852.0 of the comparison-star was, according to H. C. 33307 and B. Z. 255, 256,

∗ α	∗ δ
h. m. s.	° ′ ″
18 1 36.59	—8 47 26.4

4. At Bonn, by Professor **Argelander**, with the meridian-circle.

1852.	M. T. Bonn.	α	δ
	h m. s.	° ′ ″	° ′ ″
July 4	11 10 21.8	270 40 2.8	—8 48 47.7
5	11 5 25.6	270 24 55.3	8 53 4.9
6	11 0 29.8	270 9 55.7	8 57 25.8
7	10 55 34.8	269 55 6.6	—9 2 0.2

By four observations with the meridian-circle, **Argelander** finds the mean position of **Hind**'s comparison-star, June 24, to be

∗ α	∗ δ
° ′ ″	° ′ ″
273 20 41.7	—8 20 43.7

From the observations, London June 24, Bonn June 30 and

July 6, Messrs. SCHOENFELD and THORMANN, in Bonn, have computed the following elements and ephemeris of *Melpomene*.

Elements.

Epoch, 1852, July 0, M. T. Berlin.

M	134° 51′ 36″.3	
L	270 11 12.6	Mean Equinox of epoch.
π	135 19 36.2	
Ω	161 47 59.2	
i	8 39 50.2	
φ	3 30 35.8	
Log. a	0.3142192	
" μ	3.0786778 ($\mu = 1198''.6097$)	

The middle place is thus represented by these elements :—

C. — O.

$\Delta\lambda = -0''.17$ $\Delta\beta = -0''.02$

Ephemeris for Mean Berlin Midnight.

1852.	α h. m. s.	δ ° ′	Log △
July 11	17 56 0	—9 21.6	0.07726
12	55 8	26.9	
13	54 17	32.3	
14	17 53 28	—9 37.8	
July 15	17 52 41	—9 43.3	0.08101
16	51 55	48.0	
17	51 11	9 54.7	
18	50 29	10 0.5	
19	49 48	6.4	0.09202
20	49 10	12.5	
21	48 33	18.6	
22	47 58	24.8	
23	47 25	31.0	0.10090
24	46 54	37.3	
25	46 24	43.7	
26	45 57	50.2	
27	45 32	10 56.7	0.11058
28	45 9	11 3.3	
29	44 47	9.9	
30	44 28	16.5	
31	44 11	23.2	0.12088
Aug. 1	43 56	29.8	
2	43 43	36.6	
3	43 32	43.4	
4	17 43 22	—11 50.2	0.13176

A. C. PETERSEN.

CORRIGENDA IN NO. 45.

Page 162, col. 1, line 8, for $\frac{n^m\, n'^{n'}}{N^n}$, read $\frac{n^n\, n'^{n'}}{N^N}$.

" " 24, the second term should be squared.

" in various places, for ε', read ε_1.

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EIGHTEENTH ASTEROID.
FROM A LETTER OF DR. PETERSEN TO THE EDITOR.
CORRIGENDA IN NO. 45.

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G.

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No. 47.

VOL. II. CAMBRIDGE, 1852, AUGUST 25. NO. 23.

FROM A LETTER OF LIEUTENANT GILLISS TO THE EDITOR.

U. S. N. Astronomical Expedition, *Santiago de Chile*, 1852, *June* 10.

THERE is little of astronomical interest to communicate to you from this part of the world, except that I have been officially notified that the government of Chili have determined to establish a National Observatory at our departure, and have offered to purchase our instruments for the purpose. This will be gratifying intelligence to astronomers in every part of the world, which I beg you will cause to be made known. We hope this is not the only valuable result for which the Astronomical Expedition will have a claim on the gratitude of scientific men.

You will have learned from my letter to Mr. WALKER the progress made with the differential measures between *Mars* and the selected stars of the ephemeris up to its date. To the close of the series in March the weather continued to favor me, and there were many nights when its changes of declination between the observations were measured with a degree of accuracy affording the highest satisfaction. Besides the differential measures with the equatorial, the differences of declination and right-ascension were also observed with the meridian-circle, and after the conclusion of the series at least three observations were made to determine the position of each selected star independently. The Nautical Almanac list was also observed on the meridian. As there are about 2,000 differential measures during the series, and near 1500 in that of 1849–50, if observers at the North have been any thing like as fortunate, we have a right to expect a good result.

I commenced the concluding series with *Venus* on the 29th ultimo; but it is our winter, the planet is far north, and so far I have only had observations on two nights. The experience of last year convinced me that very little was to be expected from observations during the evening twilight, even with the advantage of season and position of the planet in declination. The morning was far more favorable, and as we are compelled to remain until the time fixed in the ephemeris, I hope to get some good measures in August and September. No star could be found in the place of H. C. No. 15551, selected for the 3d instant. What has become of it? Did one of the asteroids occupy the spot at the date of LALANDE's observation?

The zone-work goes on steadily whenever the weather will permit, and we can promise you very safely an addition of 20,000 stars to those now known, besides re-observations of nearly every one in LACAILLE between our zenith and upper zone, which has never been reëxamined. Subjoined you have a list of those in error which have not been previously communicated. The last list was sent to Captain WILLIAM H. SMYTH, R. N., whilst you were in Europe, a previous one having been sent to Professor COFFIN on the 24th of October.

The eclipse of the sun to take place on the 17th has been calculated by both Mr. MACRAE and Mr. PHELPS, and, as the moon-culminations and occultations so far give a result which seems to demand a translation of the western coast nearly five miles to the eastward, it is much to be hoped we shall have a favorable day. You will remember that the moon-culminations observed by me at Washington showed that the Capitol had been put down about two miles west of its true longitude, and it will scarcely be remarkable that Chili is double that distance in error.

I hope to have the pleasure of seeing you in the United States by the middle of November.

SIXTH LIST OF ERRORS, DETECTED BY THE U. S. N. ASTRONOMICAL EXPEDITION, IN THE CATALOGUE OF LACAILLE.

No. 1805. 4′ too far south.
" 1890. Does not exist.
" 2031. 2′ too far north.
" 2076. Does not exist.
" 2117. Two stars, one 2^{m} preceding and 13′ north, the other 30^{s} preceding and 10′ north.
" 2125. Not seen January 14 or February 8, 1852.
" 2147. 4′ too far south.
" 2152. There is a 9 mag. 30^{s} preceding and 1′ north, and a 7.8 mag. 30^{s} preceding and 10′ north.
" 2161. 6′ too far north. BRISBANE correct.
" 2196. 1′ 30″ too far north.
" 2205. Does not exist.
" 2315. 2′ too far north.
" 2391. 2′ too far north.
" 2396. 2′ 30″ too far south.
" 2416. 1′ too far south.

No. 2441. Does not exist.
" 2453. Lacaille correct.
" 2533. 2′ too far north.
" 2542. 10′ north there is a double star 8.9 mag. and an infinite number of small ones, but nothing so large as 9.10 here.
" 2591. 2′ too far south and R.A. $45^{s.}$ too great.
" 2598. Brisbane 1440 is the only star here.
" 2606. Does not exist.
" 2632. 9 too far south and R.A. $30^{s.}$ too great.
" 2670. There is a 7 mag. about 8′ north agreeing in R.A., but no star here.
" 2699. 3 too far south.
" 2708. 2′ too far south.
" 2858. 3′ too far south and $40^{s.}$ too great in R.A.
" 2866. 1′ too far north and R.A. $1^{m.}$ $30^{s.}$ too great.
" 2874. No star near this except 2883.
" 2879. Not found in two searches.
" 2889. 10′ too far south and R.A. $30^{s.}$ too little.
" 2894. 10′ too far south and R.A. $30^{s.}$ too little.
" 2905. 4′ too far north and R.A. $1^{m.}$ $0^{s.}$ too great.
" 2915. There is an 8 mag. south preceding, and a 7 mag. north following, but nothing larger than 9 here.
" 2933. 2′ too far north.
" 2989. 2′ 30″ too far south.
" 3094. R.A. $25^{s.}$ in error.
" 3128. 5′ too far north.
" 3129. No star in this place.
" 3134. A cluster.
" 3151. 3′ 30″ too far south.
" 3158. 4′ too far north.
" 3176. Brisbane is there, but not Lacaille.
" 3211. 2′ too far south.
" 3253. 7′ too far south and R.A. $30^{s.}$ too small.
" 3264. 2′ too far south.
" 3265. 6′ too far south and R.A. $30^{s.}$ too small.
" 3349. 3′ too far north.
" 3445. There is a star 1′ north and $1^{m.}$ preceding, and another 5′ south, near the proper R.A.
" 3447. $4\frac{1}{2}$′ too far north.
" 3455. 7′ too far north.
" 3457. 3′ too far south.
" 3520. No such star.
No. 3528. A cluster.
" 3530. 3′ too far north. Brisbane 2198 and 2200 both observed.
" 3531. 3′ too far north.
" 3542. 3′ too far south.
" 3645. R.A. too great $1^{m.}$, too far north 3′.
" 3708. Too far south 5′.
" 3865. Nearest star 1′ south and following $1^{m.}$ $30^{s.}$.
" 3881. A cluster, not a nebula.
" 3948. Does not exist.
" 4011. $3\frac{1}{2}$′ too far south.
" 4014. $3\frac{1}{2}$′ too far south.
" 4129. There is no other star than Brisbane 2789.
" 4158. Does not exist, but there is a 5 mag. 16′ north and $40^{s.}$ preceding.
" 4159. R.A. $3^{m.}$ $30^{s.}$ too great.
" 4164. Does not exist.
" 4182. $3\frac{1}{2}$′ too far south.
" 4210. 2′ too far south and R.A. $25^{s.}$ in error.
" 4288. There is a star preceding $2^{m.}$.
" 4304. Not found in two searches.
" 4311. Nearest large star 8′ north and $30^{s.}$ preceding.
" 4316. $1\frac{1}{2}$′ too far north.
" 4318. Nearest star 10′ north and following 45^{s}.
" 4352. Not found.
" 4375. A cluster.
" 4425. Not found.
" 4436. Does not exist here.
" 4449. The cluster round η *Argus*. No star larger than 9 mag. corresponds.
" 4474. 3′ too far north.
" 4482. 1′ too far south.
" 4512. $1\frac{1}{2}$′ too far south.
" 4561. 2′ too far north.
" 4590. Does not exist.
" 4678. Close double.
" 4879. 10′ too far north.
" 4968. There is a 10 mag. near this position, an 8 mag. 4′ north, and a 7 mag. 18′ south.
" 5275. Our declination differs from Brisbane.
" 6808. Does not exist.
" 9232. Wrong both in R.A. and Decl.

The errors given are only approximate.

J. M. GILLISS.

FROM A LETTER OF PROFESSOR SAWITSCH TO THE EDITOR.

St. Petersburg, 1852, $\frac{\textit{June } 19}{\textit{July } 1}$.

Last year I observed the total eclipse of the sun in Southern Russia. The weather was unfortunately not favorable, and it was only possible for me to observe the beginning and the end of the totality through the semi-transparent clouds, with a probable error of about a second. The place of observation was Bobrinez, a little town in the department of Cherson, in latitude +48° 3′ 30″.1, longitude $2^{h.}$ $8^{m.}$ $39^{s.}.0$ East of Greenwich.

My observations gave, —

Beginning of the total eclipse, $5^{\mathrm{h}}\ 39^{\mathrm{m}}\ 8^{\mathrm{s}}.0$ M. T. Bobrinez.
End " " 5 42 0.5

The time was obtained by the measurement of altitudes of the sun with a ten-inch reflecting-circle by Pistor and Martins; the latitude was determined by a small but excellent universal-instrument by Ertel, from the measurement of zenith-distances of *α Ursæ Minoris* and *α Aquilæ* near the meridian; the longitude, by the transportation of two chronometers by Dent and Kessels to and from the Observatory in Nicolajen. . . . . .

OBSERVATIONS WITH THE MERIDIAN-CIRCLE OF THE ST. PETERSBURG OBSERVATORY.

Opposition of Neptune.

Date.	Ψ α	Ψ δ
1851.	h. m. s.	° ′ ″
Sept. 2	22 39 13.69	—9 26 44.2
3	39 7.49	27 18.3
4	39 1.29	27 59.2
7	38 42.78	29 48.8
16	37 48.04	35 16.6
17	37 42.48	35 51.8
18	22 37 36.49	—9 36 24.3

Quadrature of Neptune.

1851.	h. m. s.	° ′ ″
Nov. 16	22 34 11.73	9 55 49.1
19	34 11.41	55 45.7
21	34 12.21	55 45.0
25	22 34 14.67	9 55 27.9

The comparison-stars were θ, φ, and ψ^3 *Aquarii*, the places given in the British Association Catalogue having been used.

Opposition of Saturn.

Date.	♄ α	Obs. — N. A.	♄ δ	Obs. — N. A.
1851.	h. m. s.	s.	° ′ ″	″
Oct. 21	1 59 40.50	+1.07	+9 15 59.5	— 9.2
22	——	——	14 20.0	— 9.5
24	58 45.56	+0.96	11 3.5	— 8.0
26	58 9.13	+1.12	7 43.5	—11.2
27	1 57 50.84	+1.11	+9 6 8.4	— 8.5
	Mean,	+1.07		— 9.3

The comparison-stars for *Saturn* and *Uranus* were *β Arietis* and ξ^2 *Ceti*.

Opposition of Uranus.

Date.	⛢ α	Obs. — N. A.	⛢ δ	Obs. — N. A.
1851.	h. m. s.	s.	° ′ ″	″
Oct. 26	2 1 22.82	—11.29	+11 47 49.9	—59.6
27	2 1 13.07	—11.58	+11 47 0.0	—59.2
	Mean,	—11.43		—59.4

Opposition of Mars, 1852.

1852.	♂ α	Obs. — N. A.	♂ δ
	h. m. s.	s.	° ′ ″
Jan. 22	8 33 6.20	+1.39	+23 23 57.7
23	31 25.88	+1.60	30 26.2
25	8 28 4.25	+1.63	+23 42 54.7
	Mean,	+1.51	

Comparison-star, v^2 *Cancri*. The declination of *Mars* is corrected for refraction only.

I should be glad to have your opinion upon the following modification of the formulas of Gauss and Encke for the determination of an orbit from three geocentric observations. I retain the notation of all the quantities as given in the *Theoria Motûs*, pp. 150 *et seq.*

If we compute

$$\tan\gamma' = \frac{\tan\beta'}{\sin(\alpha'-l')},\qquad \tan\delta' = \frac{\tan(\alpha'-l)}{\cos\gamma'},$$

in the same way as in the *Theoria Motûs*, and

$$\sin\left(\frac{\alpha+\alpha''}{2}-K\right)\tan I = \frac{\sin(\beta''+\beta)}{2\cos\beta\cos\beta''}\sec\tfrac{1}{2}(\alpha''-\alpha)$$

$$\cos\left(\frac{\alpha+\alpha''}{2}-K\right)\tan I = \frac{\sin(\beta''-\beta)}{2\cos\beta\cos\beta''}\operatorname{cosec}\tfrac{1}{2}(\alpha''-\alpha)$$

in the same way as given by Encke (*Astr. Nachr.*, No. 640 and 699). I is the inclination to the ecliptic, and N the longitude of the ascending node upon the ecliptic of a great circle passing through the geocentric places of the planet at the first and third observations.

Let now ξ' be the longitude of the point B^* (§ 158 *Th. Mot.*) where this great circle meets the great circle which connects the geocentric place of the planet in the second observation with the corresponding heliocentric place of the earth.

We then have

$$\tan\left(\xi'-\frac{l'+K}{2}\right) = \frac{\sin(\gamma'+I)}{\sin(\gamma'-I)}\tan\left(\frac{l'-K}{2}\right)$$

where $\xi' - \left(\frac{l'-K}{2}\right)$ is to be taken in the quadrant which will make ξ' but little different from α'. And we have, moreover,

$$\tan(\delta'-\sigma) = \frac{\tan(\xi'-l')}{\cos\gamma'}$$

$$a = \frac{R\sin(l-K)}{R''\sin(l''-K)}$$

$$b = \frac{\sin\delta' R'\sin(l'-K)}{\sin(\delta'-\sigma)R''\sin(l''-K)}.$$

The quantities σ, a, b denote here the same quantities as with Gauss. And retaining also the same signification for R, R', r', r'', Q, P,

$$\frac{2R'^3\sin^3\delta'}{Q}\left(\frac{1+P}{a+P}\right)b\sin\sigma = \frac{1}{m}\sin q$$

$$\frac{2R'^3\sin^3\delta'}{Q}\left[\frac{1+P}{a+P}\,.\,b\cos\sigma-1\right] = \frac{1}{m}\cos q$$

$$m \sin^4 z' = \sin (z' - q) \; ; \; \frac{n''}{n} = P$$

$$r = \frac{R' \sin \delta'}{\sin z'} \; ; \; \frac{n'}{n} = \frac{(P + a) \sin z'}{b \sin (z' - \sigma)}.$$

Let now (ϱ), (ϱ'), (ϱ'') be the projections upon the ecliptic of the distances ϱ, ϱ', ϱ'' of the planet from the earth, we shall have

$$(\varrho') = R' \cos \beta' \frac{\sin (\delta' - z')}{\sin z'}$$

$$(\varrho) = \frac{n'}{n} \cdot \varrho' \cdot \frac{\sin (a'' - a')}{\sin (a'' - a)} - \frac{n'}{n} R' \frac{\sin (l' - a'')}{\sin (a'' - a)} + \frac{n''}{n} R'' \frac{\sin (l'' - a'')}{\sin (a'' - a)} + R \frac{\sin (l - a'')}{\sin (a'' - a)}$$

or when the geocentric motion is greater in latitude than in longitude,

$$(\varrho) = \frac{n'}{n} (\varrho') \left[\frac{\tan \beta' \sin (a'' - l'') - t_g \beta'' \sin (a' - l'')}{\tan I \sin (l'' - K) \sin (a'' - a)} \right] + \frac{R \sin (l'' - l) \tan \beta'' \left[\frac{n'}{n} \cdot \frac{R'}{R} \cdot \frac{\sin (l'' - l')}{\sin (l'' - l)} - 1 \right]}{\tan I \sin (l'' - K) \sin (a'' - a)}$$

and ϱ'' may be determined in a similar manner. This last formula has been given by Mr. Encke.

The remaining portion of the computation seems to me to be most convenient when carried out as indicated by Encke in the *Astronomische Nachrichten*, No. 699. Should this modification meet with your approval, will you please give it a place in your *Astronomical Journal*.

I have recently seen at the Pulkowa Observatory an admirable little vertical-circle, of about ten inches in diameter, constructed by Repsold in Hamburg, and provided with microscopes and micrometer-screws. It has been obtained for determining latitudes in our trigonometrical survey. Since similar operations are going on with you, it may be interesting for you to know of it. The price is about six hundred thalers.

A. SAWITSCH.

LETTER FROM PROFESSOR BACHE TO THE EDITOR.

Coast Survey Station, near Petersburg, Va., 1852, *July* 29.

I communicate herewith for publication in the *Astronomical Journal*, by authority of the Treasury Department, the results of preliminary observations for latitude made at six localities on the western coast by Assistant George Davidson, during an expedition in the surveying steamer "Active," under the command of Lieutenant James Alden, United States Navy, and Assistant in the Coast Survey. The expedition was undertaken in April last, for reconnoitering the coast between San Francisco and San Diego, and determining the latitudes and differences of longitude for the points and islands between those places.

The observations for latitude were made with the zenith-telescope (U. S. C. S. No. 3), by Talcott's method, on from five to ten pairs of stars at each locality stated below, and, as the party remained only one clear night at a station, each pair of the stars selected was observed but once.

The latitudes for these localities are communicated in advance of the completion of the computations of the observations for difference of longitude, as they are considered of sufficient importance to be made known at once.

The results were obtained by Mr. Charles Schott, of the Coast Survey, who recomputed Mr. Davidson's data, giving weights according to the probable error of the stars taken from the British Association Catalogue, and the Greenwich Twelve-Year Catalogue. Assistant Davidson had taken one third of all the stars he observed from the latter Catalogue. The mean of the results from the Coast Survey determinations of the errors of the places of the stars, as given in these Catalogues, gives the square of the probable error, e^2, of a pair of stars from the British Association Catalogue $= 1''.5$; e^2 for a pair from the Twelve-Year Catalogue $= 0''.5$; and e^2 from Mr. Davidson's observations $= 0''.5$. We have therefore the weights of a pair of stars by

British Association Catalogue, ... = 2
British Association Catalogue and Twelve-Year Catalogue, . = 3
Twelve-Year Catalogue, ... = 4.

The following Table contains Mr. Davidson's results.

Name of Station.	General Locality.	Pairs of Stars computed.	Latitude.	Probable Error of Result.
Santa Cruz,	Bay of Monterey, California,	6	36° 57′ 27″	±0″.25
San Simeon,	San Simeon Bay, "	5	35 38 24	±0.88
San Luis Obispo,	San Luis Obispo Bay, California,	8	35 10 37	±0.47
Santa Barbara,	Santa Barbara Channel, California,	7	34 24 25	±0.31
Prisoner's Harbor,	Island Santa Cruz, California,	5	34 1 10	±0.77
San Pedro,	San Pedro Bay, California,	8	33 43 20	±0.28

A. D. BACHE.

OBSERVATIONS OF MELPOMENE, THETIS, IRENE, AND EUNOMIA,

MADE AT THE CAMBRIDGE OBSERVATORY (ENGLAND).

By PROFESSOR JAMES CHALLIS,
DIRECTOR OF THE OBSERVATORY.

The equatorial observations were made with the 20-foot Refractor.

MELPOMENE.

1852.	Greenwich M. T.	⑱ R.A.	Log $\frac{p}{P}$	⑱ N. P. D.	Log $\frac{q}{P}$	No. Comp.	*
	h. m. s.	h. m. s.		° ′ ″			
June 26	12 25 27.6	18 10 55.16	+7.811	98 21 10.7	—9.9377	8	*a*
29	11 34 38.5	18 7 48.46				Meridian	
	12 18 18.8	18 7 46.53	+7.896	98 30 18.0	—9.9381	8	*b*
30	11 29 40.0	18 6 45.70		98 33 36.1	—9.9392	Meridian	
July 1	11 24 42.0	18 5 43.41		98 37 7.2	—9.9394	"	
3	11 14 47.1	18 3 40.04		98 44 49.5	—9.9400	"	
5	11 4 53.7	18 1 38.09		98 53 12.3 (?)	—9.9406	"	
6	10 59 58.4	18 0 38.56		98 57 30.9	—9.9409	"	
7	10 55 3.5	17 59 39.43		99 2 4.9	—9.9412	"	
8	10 50 9.0	17 58 40.65		99 6 45.7	—9.9415	"	
9	10 45 15.5	17 57 42.86		99 11 32.3	—9.9418	"	
12	10 30 41.8	17 54 56.43		99 27 1.0	—9.9429	"	
15	10 16 17.8	17 52 19.79		99 43 33.8	—9.9440	"	
17	10 6 48.5	17 50 42.04					
19	9 57 25.6	17 49 10.74		100 7 28.4	—9.9456	"	
22	9 43 31.6	17 47 4.05		100 26 29.3	—9.9469	"	
23	9 38 57.0	17 46 25.29		100 33 1.5	—9.9473	"	

The stars *a* and *b* are XVIII. 265 and XVIII. 213 in Weisse's Catalogue, from which the following adopted mean places were taken: —

	Mean R.A. 1852.0.	Mean N. P. D. 1852.0.
	h. m. s.	° ′ ″
a	18 12 2.15	98 2 20.6
b	18 10 3.41	98 41 5.1

THETIS.

1852.	Greenwich M. T.	⑰ R.A.	Log $\frac{p}{P}$	⑰ N. P. D.	Log $\frac{q}{P}$	No. Comp.	*
	h. m. s.	h. m. s.		° ′ ″			
July 5	10 41 6.8	12 33 3.79	+8.600	87 10 25.6	—9.8931	2	*a*
	10 51 50.8	12 33 4.49	+8.605	87 10 31.7	—9.8922	1	*b* and *c*
7	9 59 16.4	12 35 26.04	+8.577	87 29 31.8	—9.8896	1	*d* and *e*
	10 20 4.9	12 35 26.86	+8.591	87 29 42.3	—9.8908	2	*a*
	10 35 11.6	12 35 26.86	+8.599	87 29 48.3	—9.8919	2	*f*
8	10 22 5.5	12 36 40.21	+8.595	87 39 32.8	—9.8916	5	*f*

The planet was very faint. Some of the measures on each day were taken while the instrument was carried by clock-movement, the differences of R.A. being measured on a graduated sector attached to the hour-circle.

Assumed Mean Places of the Stars.

	Mean R A. 1852.0.	Mean N. P. D. 1852 0.	Authority.
	h. m. s.	° ′ ″	
a	12 30 49.67	87 19 49.0	B. A. C. 4254
b	13 0 3.23	87 43 51.5	H. C. 24373
c	13 1 27.52	87 2 53.8	Weisse XIII. 2
d	12 43 33.19	87 19 30.9	Weisse XII. 744
e	12 45 0.77	87 15 3.4	" 765
f	12 31 50.07	87 34 11.9	" 583

IRENE.

1852.	Greenwich M. T.	⑭ R.A.	Log $\frac{p}{P}$	⑭ N. P. D.	Log $\frac{q}{P}$	No. Comp.	*
	h. m. s.	h. m. s.		° ′ ″			
July 9	13 56 44.6	23 40 56.96	—8.412	103 28 38.4	—9.9136	5	*a*
12	13 36 26.8	23 41 21.38	—8.433	103 39 14.9	—9.9422	6	*b*
15	12 47 4.3	23 41 35.09	—8.506	103 51 0.4	—9.9341	8	*c*

Assumed Mean Places of the Stars.

	Mean R.A. 1852.0.	Mean N. P. D. 1852.0.	Authority.
	h. m. s.	° ′ ″	
a	23 36 10.46	103 50 3.2	Weisse XXIII. 740
b	23 43 18.10	103 38 40.8	" 883
c	23 42 53.57	103 56 2.3	" 876

EUNOMIA.

1852.	Greenwich M. T.	⑮ R.A.	Log $\frac{p}{P}$	⑮ N. P. D.	Log $\frac{q}{P}$	No. Comp.	*
	h. m. s.	h. m. s.		° ′ ″			
July 19	13 35 9.7	3 16 30.40	—8.670	61 0 26.8	—9.8285	1	*a*
22	13 16 37.4	3 22 22.40	—8.672	60 32 48.2	—9.8371	3	*b*
23	12 29 47.2	3 24 15.49	—8.664	60 24 2.5	—9.8722	8	*c*

Assumed Mean Places of the Stars.

	Mean R A. 1852.0.	Mean N. P. D. 1852.0.	Authority.
	h. m. s.	° ′ ″	
a	3 11 23.99	61 29 30.3	B. A. C. 1025
b	3 21 12.80	60 28 16.0	H. C. 6405 and 6406
c	3 23 5.85	60 30 2.0	H. C. 6466 and 6467.

MELPOMENE.

Dr. Petersen with his usual kindness has communicated the following additional observations of this eighteenth asteroid:—

1. Göttingen,—by Dr. Westphal with the transit-instrument, and Mr. Klinkerfues with the Repsold meridian-circle.

1852.	M. T. Göttingen.	⑱ α	⑱ δ	
	h. m. s.	h. m. s.	° ′ ″	
July 4	11 10 22.18	18 2 40.87		T. I.
5	11 5 25.84	18 1 40.27		"
	24.37	39.80	—8 53 2.5	M. C.
6	11 0 30.19	18 0 40.37		T. I.
	30.07	40.25	8 57 17.6	M. C.
7	10 55 35.12	17 59 41.05		T. I.
	34.84	40.77	9 1 55.0	M. C.
8	10 50 40.96	17 58 42.66		T. I.
	40.95	42.65	9 6 48.5	M. C.
9	10 45 47.40	17 57 44.85		T. I.
	47.66	45.11	9 11 28.1	M. C.
10	10 40 55.22	17 56 48.43		T. I.
			—9 16 21.9	M. C.
11	10 36 3.68	17 55 52.65		T. I.
July 11	10 36 3.54	17 55 52.51	—9 21 28.4	M. C.
12	10 31 13.25	17 54 57.99		T. I.
			9 26 48.0	M. C.
13	10 26 24.26	17 54 4.75		T. I.
14	10 21 36.16	17 53 12.42		"
15	10 16 49.28	17 52 21.33		"
			9 43 23.5	M. C.
16	10 12 3.83	17 51 31.65		T. I.
			9 49 17.1	M. C.
17	10 7 20.00	17 50 43.59		T. I.
	19.86	43.45	9 55 4.1	M. C.
19	9 57 56.00	17 49 11.09	10 7 18.3	"
20	9 53 16.66	17 48 27.61		T. I.
	17.08	28.03	10 13 30.6	M. C.
21	9 48 38.78	17 47 45.53		T. I.
	38.46	45.22	10 19 50.1	M. C.
23	9 39 28.58	17 46 26.94		T. I.
24	9 34 55.40	17 45 49.57		"
			10 39 17.7	M. C.
25	9 30 24.41	17 45 14.40	—10 46 3.4	"

2. Marburg, — by Mr. **Lesser** with the ring-micrometer.

1852.	M. T. Marburg. h. m. s.	⑱ α	⑱ δ	No. Comp.	*
July 8	11 33 32.8	269° 40′ 6″.8		19	*a*
	11 56 44.7		—9° 6′ 53″.7		
9	11 16 51.5	269 25 53.9		17	*a*
	11 19 36.4		—9 11 55.2		
10	11 16 17.9	269 11 39.5		19	*b*
	11 16 7.2		—9 16 35.8		
11	10 57 51.0	268 57 51.7		11	*b*
	11 12 49.0		—9 21 37.2		

Apparent Places of the Comparison-Stars.

July 8	*a*	269° 52′ 12″.6	—9° 11′ 25″.4	Weisse XVII. 1260
9	*a*	52 12.65	11 25.4	
10	*b*	269 24 48.7	—9 16 3.2	Weisse XVII. 1212
11	*b*	24 48.8	16 3.1	

3. Kremsmünster, — by Professor **Reslhuber** with the meridian-circle.

1852.	M. T. Kremsmünster. h. m. s.	⑱ α h. m. s.	⑱ δ
July 4	11 10 25.80	18 2 41.74	—8° 48′ 34″.32
6	11 0 33.55	18 0 40.98	8 57 22.90
7	10 55 39.02	17 59 42.21	9 1 55.84
8	10 50 34.77	58 43.54	6 33.88
11	10 36 6.99	55 53.21	21 32.66
13	10 26 27.37	54 5.11	32 11.76
14	10 21 39.40	53 12.91	37 47.04
15	10 16 52.67	52 21.96	43 28.15
16	10 12 7.48	17 51 32.55	—9 49 13.19

Professor **Rümker** has sent me the following Hamburg Observations: —

1852.	M. T. Hamburg. h. m. s.	⑱ α h. m. s.	⑱ δ	No. Comp.
June 28	12 7 31.8	18 8 51.380	—8° 27′ 5″.32	10
30	10 16 50.5	18 6 50.894	8 33 24.08	3
July 2	12 42 27.7	18 4 40.118	8 41 1.9	15
3	12 0 24.3	18 3 39.864	8 44 52.4	19
4	10 26 39.1	18 2 42.691	8 48 44.1	9
4	11 10 21.9	18 2 40.569	—8 48 50.9	M. C.
July 5	10 20 16.3	18 1 41.806	—8° 52′ 53″.5	14
5	11 5 25.8	18 1 40.216	8 53 5.8	M. C.
6	11 0 30	18 0 40.130	8 57 26.8	"
7	10 55 34.9	17 59 40.816	9 2 1.0	"
8	10 50 40.8	17 58 42.434	9 6 41.6	"
9	10 45 47.2	17 57 44.546	—9 11 29.8	"

Messrs. **Schönfeld** and **Thormann** have computed new elements, their former computation having been vitiated, without fault of their own, by a mistake in one of the fundamental places. The new orbit is as follows: —

Epoch, 1852, July 0, M. T. Berlin.

M	283° 7′ 54″.44	
L	299 15 38.98	Mean Equinox of epoch.
π	16 7 44.54	
☊	149 51 49.78	
i	10 11 46.87	
φ	12 24 35.41	
Log. *a*	0.3606775	
" μ	3.0089905	

NEW COMET.

Dr. **Westphal**, Assistant at the Göttingen Observatory, discovered, July 24, a new comet about 1¾° south of *f Piscium*. It appeared in the comet-seeker as a tolerably bright nebula, several minutes in diameter.

At midnight, July 24, Dr. **Westphal** estimated the apparent place of the comet as

$$\alpha = 1^{h}\ 11^{m}.7 \qquad \delta = +1^\circ\ 4'.$$

July 25, the comet was near the star **Weisse** I. 197. By comparison with this star Mr. **Klinkerfues** found the position

	M. T. Göttingen. h. m. s.	App. α h. m. s.	App. δ
July 25	13 55 20	1 12 59.4	+1° 44′

and Dr. **Westphal** found by estimation

	h. m.	h. m.	
July 25	13 45	1 13.1	+1° 47′.

G.

Cambridge, 1852, *August* 13.

ELEMENTS OF PSYCHE.

By Mr. JAMES FERGUSON.

M	210° 31′ 36″.1	June 1.0 M. T. Berlin.
π	318 51 4.5	Mean Equinox, 1852.
☊	149 47 0.6	
i	2 57 27.5	
φ	1 40 26.5	
Log. a	0.5102511	
" μ	2.7816251	

These elements have been computed from observations made at London, Hamburg, and Washington, which, reduced to the mean equinox of 1852, and corrected for aberration, give the following places: —

1852, M. T. Berlin.	⑯ α	⑯ δ	
April 4.41360	147° 45′ 41″.93	+13° 38′ 52″.7	Astr. Nachr., No. 807
26.42168	147 56 8.23	13 45 3.7	" " 809
May 18.60614	150 22 42.59	13 0 31.5	Astr. Journal, No. 45
June 9.63976	151 30 0.74	+11 35 19.7	" "

NEW ELEMENTS OF EUNOMIA.

By Mr. GEORGE RÜMKER.

Epoch, 1851, August 21.0.

M	314° 4′ 38″.39	1852, Jan. 0.0, M. T. Berlin.
π	28 11 58.00	Mean Equinox, 1852, Jan. 0.
☊	293 54 48.29	
i	11 43 56.47	
φ	10 47 29.24	
Log. a	0.4214854	
" μ	827.5200.	

These elements are computed from the following normal positions: —

Date. M. T. Berlin.	App. R.A.	App. Decl.	
1851, Aug. 21.0	271° 54′ 37″.48	—21° 25′ 32″.18	Founded upon 9 Cambridge and 1 Berlin Observation.
Oct. 20.0	282 43 58.77	—20 45 55.20	" 1 Camb., 5 Berlin, 2 Hamb., and 5 Wash'n Obs.
1852, Jan. 9.0	316 17 9.35	—11 49 2.48	" 4 Washington Observations.

They represent the middle observation thus: —

$$\text{Calculation} - \text{Observation} \begin{cases} +0.11 \text{ in Longitude.} \\ -0.06 \text{ in Latitude.} \end{cases}$$

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OBSERVATIONS OF EGERIA, THETIS, AND IRENE,

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By Mr. JAMES FERGUSON.

[Communicated by Lieutenant Maury.]

[Corrected for refraction.]

EGERIA.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	⑬ — *		⑬'s apparent		A.
				Δα	Δδ	α	δ	
	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″	
1851, Nov. 26	14 1 23.1	4	Bessel's Zones 502 (2)	+1 33.15	— 0 12.08	11 34 3.59	+20 57 12.80	7
	14 2 27.6	1	" 502 (1)	+3 19.32	+ 2 2.83	11 34 2.54	20 57 17.95	7
28	15 33 16.3	6	" 496 (1)	—0 40.82	+ 6 20.24	11 36 57.58	20 49 9.21	10
		6	" 496 (2)	—2 48.84	— 2 13.98	11 36 57.76	20 49 3.09	10
		6	B. A. C. 3990	—3 21.16	—13 25.32	11 36 57.86	20 49 10.20	10
Dec. 1	14 12 18.5	7	Bessel's Zones 496 (1)	+3 21.59	— 4 26.52	11 41 0.10	20 38 22.17	8
		7	" 496 (2)	+1 13.05	—12 56.81	11 40 59.68	20 38 19.53	8
1852, Feb. 3	11 31 33.1	2	" 467 (1)	+0 36.01	+ 2 26.48	12 25 20.54	21 46 36.65	9
14	10 38 4.3	4	" 467 (2)	—0 6.54	— 1 28.56	12 21 16.27	22 47 49.84	8
17	9 53 50.5	5	" 467 (3)	+2 25.08	+ 5 20.86	12 19 29.53	23 4 41.94	9
March 3	10 4 56.2	1	" 412 (1)	—0 8.52	—14 3.27	12 6 49.23	24 15 12.72	8
7	9 12 30.4	11	" 412 (2)	+2 11.94	— 3 59.25	12 2 42.28	24 27 26.55	10
10	10 3 20.3	8	" 412 (2)	—1 3.97	+ 2 57.58	11 59 27.06	24 34 25.18	10
18	9 40 2.2	3	" 503	—0 52.31	— 2 55.53	11 50 38.06	24 40 48.11	9
31	9 13 2.0	10	Rümker 3738	—2 7.64	—20 35.58	11 37 13.61	24 11 51.06	7
April 2	9 22 31.4	6	Bessel's Zones 353	+4 23 02	— 5 45.48	11 35 23.84	24 3 6.32	7
7	9 50 18.4	4	*a*	—0 39.99	+19 22.07	11 31 14.52	23 36 25.81	10
9	9 42 36.8	3	*a*	—2 8.76	+ 6 58.70	11 29 45.75	23 24 1.72	10
10	8 9 53.8	7	*a*	—2 48.48	+ 0 52.53	11 29 5.98	23 17 56.04	10
13	7 54 51.6	20	Bessel's Zones 496 (3)	+0 41.11	+ 6 37.81	11 27 8.94	22 57 0.03	10
15	7 58 49.1	20	" 496 (3)	—0 28.77	— 8 23.65	11 25 59.00	22 41 57.82	10
23	8 15 13.6	10	" 496 (4)	+3 47.29	+14 2.87	11 22 29.19	21 34 3.27	10
24	10 48 56.0	5	" 496 (4)	+3 26.99	+ 3 49.24	11 22 9.29	21 23 48.79	9
		5	" 496 (5)	+3 40.98	+11 5.60	11 22 9.12	21 23 49.98	9
25	8 12 51.6	5	" 496 (4)	+3 12.73	— 4 38.98	11 21 55.02	21 15 20.68	9
		5	" 496 (5)	+3 26.71	+ 2 38.39	11 21 54.43	21 15 24.16	9
May 7	9 19 50.1	1	B. A. C. 3915	—1 51.31	— 1 30.89	11 20 51.76	19 11 57.70	7
10	10 33 6.8	5	Rümker 3575	+2 25.63	— 2 16.27	11 21 12.15	18 38 8.23	10
	10 37 14.1	4	" 3615	—2 36.00	+ 4 5.35	11 21 12.41	18 38 5.18	10
20	10 37 31.6	3	Bessel's Zones 457	—3 19.78	— 6 50.78	11 24 1.62	16 42 50.38	10
25	10 15 59.7	16	Rümker 3636	—0 14.33	+ 0 3.08	11 26 11.95	15 42 42.08	10
June 10	10 43 31.0	4	" 3706	+1 27.74	—17 5.42	11 36 29.94	12 23 53.93	9
July 8	8 45 9.3	13	B. A. C. 4096	+0 35.48	—13 58.22	12 3 6.60	6 23 48.61	10
9	8 52 4.7	20	Weisse XII. 53	—0 11.58	+ 0 51.22	12 4 12.88	6 10 48.43	10
10	9 14 7.0	8	" 53	+0 56.07	—12 21.18	12 5 20.52	5 57 35.13	10
11	8 47 51.0	11	" 91	—0 5.29	— 4 35.46	12 6 27.49	5 41 49.00	10
Aug. 1	8 32 23.5	5	" 515	+0 50.24	+ 9 28.59	12 31 49.03	+ 1 11 23.03	10
7	8 34 41.2	4	" 661	+0 38.84	— 5 44.76	12 39 36.76	— 0 6 10.90	8

Adopted Mean Places, 1850.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.	No. of Comp.
		h. m. s.	° ′ ″		
Bessel's Zones 502 (1)	8	11 30 38.75	+20 55 50.23	Rümker's Catalogue, 3761.	
" 502 (2)	9	11 32 25.87	20 57 59.81	Bessel's Zones.	
" 496 (1)	7	11 37 34.05	20 13 25.05	Rümker's Catalogue, 3728.	
" 496 (2)	7.8	11 39 42.20	20 51 52.36	Bessel's Zones.	
B. A. C. 3990	4	11 40 14.66	21 3 10.70	British Association Catalogue.	
Bessel's Zones 467 (1)	8.9	12 24 38.40	21 44 56.72	Bessel's Zones.	
" 467 (2)	8.9	12 21 16.37	22 50 5.53	"	
" 467 (3)	8.9	12 16 57.91	23 0 8.00	"	
" 412 (1)	7.8	12 6 50.85	24 30 2.78	Wichman, A. N. 806.	
" 412 (2)	7.8	12 0 23.34	24 32 12.19	Wichman and Rümker, A. N. 806, 809.	
" 503	8.9	11 51 23.23	24 44 28.63	Rümker, A. N. 809.	
Rümker 3738	6.7	11 39 14.04	24 33 9.63	" "	
(¹) Bessel's Zones 353	(8)	11 30 53.59	24 9 34.10	Washington Observations.	
Rümker 3697	9	11 34 17.28	23 2 41.04	Rümker's Catalogue.	
a	9	11 31 47.32	23 17 45.13	Washington Equatorial.	4
Bessel's Zones 496 (3)	8.9	11 26 20.63	22 51 2.32	Bessel's Zones.	
" 496 (4)	8	11 18 34.82	21 20 40.30	Rümker, A. N. 809.	
" 496 (5)	8	11 18 20.67	21 13 25.47	" "	
B. A. C 3915	5½	11 22 39.16	19 14 7.66	Mean from Rümker and B. A. C.	
Rümker 3575	9	11 18 39.65	18 41 3.50	Rümker's Catalogue.	
" 3615	6	11 23 41.53	18 34 38.94	"	
Bessel's Zones 457	9	11 27 14.63	16 50 20.02	Bessel's Zones.	
Rümker 3636	8	11 26 19.58	15 13 17.79	Rümker's Catalogue.	
" 3706	8	11 34 55.66	12 41 38.16	"	
B. A. C. 4096	6	12 2 24.76	6 38 26.16	Santini's Catalogue, 829.	
Weisse XII. 53	9	12 4 18.09	6 10 35.60	Rümker's Catalogue.	
" 91	9	12 6 26.43	5 50 3.46	Weisse's Catalogue.	
" 515	8.9	12 30 52.49	+1 2 3.85	"	
" 661	8	12 38 51.63	—0 0 6.94	"	

(¹) There is an error of +10 seconds in the α of this star in Bessel's Zones. The star has also been observed by Rümker, *Astronomische Nachrichten*, No. 809.

THETIS.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	⑰ — * Δα	⑰ — * Δδ	⑰'s apparent α	⑰'s apparent δ	A.
1852.	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″	
May 18	10 13 27.6	2	Weisse XI. 947	+1 17.46	— 5 20.18	11 56 29.50	+8 33 22.95	10
19	12 16 11.1	9	" 947	+1 33.21	— 9 38.61	11 56 45.23	8 29 4.59	10
20	9 56 21.2	8	" 947	+1 48.17	—13 20.48	11 57 0.18	8 25 22.77	10
31	10 22 9.8	6	" 1023	+1 31.62	— 6 12.56	12 1 44.01	7 29 23.21	10
June 2	10 33 37.9	4	" 1023	+2 44.20	—18 30.82	12 2 53.59	7 17 5.02	10
9	10 15 48.2	4	Weisse XII. 63	+2 51.62	—12 8.35	12 7 38.57	6 29 49.18	8
	11 51 18.3	2	" 63	+2 57.06	—12 26.57	12 7 41.01	6 29 30.79	8
10	10 11 55.9	4	Rumker 3907	—3 43.51	+ 0 27.69	12 8 21.03	6 22 37.42	8
		4	" 3911	—3 59.19	— 6 52.19	12 8 21.28	6 22 38.79	8
11	9 57 51.2	4	" 3907	—2 57.30	— 6 49.72	12 9 10.25	6 15 20.10	10
		4	" 3911	—3 12.83	—14 12.39	12 9 10.64	6 15 18.65	10
13	9 15 2.0	4	Weisse XII. 160	+0 11.66	+ 5 18.26	12 10 47.64	6 0 20.58	10
15	9 30 8.3	6	"	+1 53.12	—10 10.31	12 12 16.85	5 41 52.17	8
	11 11 12.1	3	"	+1 56.71	—10 42.21	12 12 20.44	5 41 20.27	8
20	9 50 3.0	6	Rümker 3966	—1 17.30	+ 2 47.21	12 17 4.98	5 3 56.56	8
29	9 16 46.3	4	Weisse XII. 433	+0 17.30	+ 1 17.22	12 26 21.76	3 41 57.94	8
	10 2 4.2	4	" 433	+0 18.84	+ 0 44.91	12 26 23.30	3 41 25.63	8
July 2	10 1 31.9	3	" 463	+2 2.61	+11 57.81	12 29 46.87	3 16 25.53	8
	10 27 36.3	3	" 463	+2 3.67	+11 48.14	12 29 47.92	3 16 15.87	8
3	10 16 51.1	6	" 463	+3 12.51	+ 2 23.57	12 30 56.85	3 7 1.37	9
5	9 45 18.7	6	Santini 861	+2 25.84	+ 7 41.57	12 33 15.57	2 47 53.27	9
		6	Weisse XII. 564	—0 43.54	— 0 43.52	12 33 15.68	+2 47 53.06	9

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	⑰ — *		⑰'s apparent		A.
				$\Delta\alpha$	$\Delta\delta$	α	δ	
1852.	h. m s.			m. s.	′ ″	h m. s.	° ′ ″	
July 8	9 46 19.6	6	Weisse XII. 583	+2 3.03	— 7 9.29	12 36 53.52	+2 18 38.67	10
	10 6 49.6	3	" 584	+1 59.56	+ 9 48.09	12 36 55.09	2 18 24.35	10
9	9 53 44.5	6	" 584	+3 12.85	+ 0 2.55	12 38 8.36	2 8 39.24	10
10	10 2 31.8	5	" 638	+1 37.55	+ 6 33.73	12 39 23.59	1 58 40.50	10
15	9 8 20.3	8	" 764	+0 53.13	+ 6 13.99	12 45 46.66	1 8 16.27	9
	9 8 56.9	7	" 757	+1 29.35	+14 46.71	12 45 46.77	1 8 18.46	9
18	8 54 23.9	5	" 818	+1 41.70	—14 6.96	12 49 46.36	0 37 24.03	10
19	8 37 35.3	6	Lalande 24193	—1 12.79	— 7 5.62	12 51 7.47	0 27 14.21	10
	8 54 57.5	6	"	—1 11.86	— 7 12.72	12 51 8.40	0 27 7.11	10
	9 12 35.8	3	"	—1 11.02	— 7 19.55	12 51 9.24	0 27 0.28	10
20	8 57 39.8	10	"	+0 10.47	—17 41.67	12 52 30.71	+0 16 38.23	10
Aug. 2	8 50 4.3	5	Weisse XIII. 181	+0 2.55	—18 29.91	13 11 21.03	—2 3 30.39	10
6	8 37 29.9	12	" 294	—1 7.94	+ 5 55.01	13 17 22.57	2 47 30.71	8
7	9 2 29.1	2	" 294	+0 26.76	— 5 16.79	13 18 57.26	2 58 42.45	8
14	8 25 29.7	7	" 501	+0 19.49	—13 25.43	13 30 1.93	4 16 16.66	8
15	8 30 25.8	7	" 563	—1 4.28	+ 2 16.08	13 31 39.67	—4 27 48.06	8

Adopted Mean Places, 1850.0, *of Comparison-Stars.*

*	Mag.	α	δ	Authority.
		h. m. s.	° ′ ″	
Weisse XI. 947	9	11 55 5.20	+8 39 25.23	Weisse's Catalogue.
" 1023	9	12 0 2.69	7 36 17.21	" "
Weisse XII. 63	8	12 4 37.82	6 42 38.58	" "
Rümker 3907	8.9	12 12 0.86	6 22 50.73	Rümker's Catalogue.
" 3911	8	12 12 16.79	6 30 11.92	" "
Weisse XII. 160	9	12 10 29.33	5 55 43.27	Weisse's Catalogue.
Rümker 3966	8	12 18 15.54	5 1 50.00	Rümker's Catalogue.
Weisse XII. 433	9	12 25 57.88	3 44 22.27	Weisse's Catalogue.
" 463	9	12 27 37.69	3 5 8.08	" "
" 513	7	12 30 43.13	2 40 51.92	Santini's Catalogue (861).
" 564	9	12 33 52.65	2 49 16.87	Weisse's Catalogue.
" 583	9	12 34 43.95	2 26 27.94	" "
" 584	8.9	12 34 48.98	2 9 16.33	" "
" 638	9	12 37 39.49	1 52 47.73	" "
" 764	9	12 44 46.99	1 2 41.98	" "
" 757	8	12 44 10.88	0 54 11.52	Mean of Weisse and Santini 876
" 818	7	12 47 58.13	0 52 10.42	" " " 879
Lalande 24193	8.9	12 52 13.72	+0 31 59.12	Lalande's Catalogue.
Weisse XIII. 181	9	13 11 12.16	—1 41 22.32	Weisse's Catalogue.
" 294	8.9	13 18 23.95	2 52 47.72	" "
(1) " 501	8.9	13 29 35.88	4 2 14.00	" "
" 563	8.9	13 32 37.38	—4 29 27.06	" "

(1) This star is 4377 of Rümker's Catalogue. There is a difference of 1 minute in declination between Rümker's place and that of Bessel. Bessel's place has been adopted in the comparison.

IRENE.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	⑭ — *		⑭'s apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1852	h. m. s			m. s	′ ″	h. m. s	° ′ ″
Aug. 31	10 5 24.0	2	Lalande 45804	+3 31.41	— 7 50.79	23 19 40.20	—18 43 41.97
Sept. 1	10 35 47.3	10	"	+2 38.93	—14 16.08	18 47.74	18 50 7.27
	10 41 17.5	7	Lalande 45838	+1 19.44	+ 4 7.14	18 47.91	18 50 7.20
2	10 28 24.2	2	"	+0 28.50	— 1 54.08	23 17 56.97	—18 56 8.43

Adopted Mean Places, 1850.0, *of Comparison-Stars.*

*	Mag.	α	δ
		h. m. s.	° ′ ″
Lalande 45804	8	23 16 0.11	—18 36 45.74
" 45838	9	23 17 19.76	—18 55 8.93

FROM A LETTER OF DR. PETERSEN TO THE EDITOR.

Altona, 1852, *August* 24.

I inclose you elements and ephemerides of the new comet and of *Melpomene*, the former by Sonntag, here, the latter sent to me from Bonn.

The new comet is now very easy to observe, and very beautiful. Its nucleus is very distinct, but no indications of a tail are visible in my small telescope. It has been observed here every night, and this morning with the meridian-circle also; but yet I am sorry to say that I can send you none of the observations to-day, as Mr. Sonntag has not had time to reduce the comparisons. The only one that is reduced is mine of the 16th instant (twelve comparisons): —

1852.	M. T. Altona. h. m. s.	α h. m. s.	δ ° ′ ″
Aug. 16	13 18 41.3	1 38 12.03	+20 48 54.5

As soon as the comparison-stars have been determined with the meridian-circle, both for these observations and for those already printed, I propose to send you the definite results for the entire series.

The comet was also discovered, August 9, in Constantinople, by Dr. C. H. F. Peters, who has sent me, in a letter dated August 12, a very minute description of its position in the heavens with relation to neighboring stars for the 9th, 10th, and 11th instants, as he was not in possession of any instruments with which observations could be made. Of course he could have had no information of the numerous and constant observations since July 24.

I have sent you a box containing some of the recent volumes of the *Astronomische Nachrichten*, for those of your countrymen who may desire them.

A. C. PETERSEN.

SECOND COMET OF 1852.

Mr. Ferguson has sent (communicated by Lieutenant Stedman, Acting Superintendent of the Washington Observatory) the following observations of the new comet: —

1852.	M. T. Washington. h. m. s.	No. Comp.	Comp.-Star.	☄ — * Δα m. s.	☄ — * Δδ ′ ″	☄'s Apparent α h. m. s.	☄'s Apparent δ ° ′ ″
Sept. 5	9 59 28.8	8	Argel. Zones 145, 126	—1 17.44	+13 16.11	2 1 5.16	+49 7 5.95
		8	Argel. Zones 153, 111	—2 4.56	+ 2 7.36	2 1 5.47	49 7 9.78
7	9 31 45.7	10	Groombridge 466	—0 7.00	— 3 42.14	2 3 26.27	52 17 59.48
8	9 40 46.1	12	Argel. Zones 151, 131	+0 1.79	+ 4 57.00	2 4 55.96	+53 55 6.89

The adopted mean places of the comparison-stars were

*	Mag.	h. m. s.	° ′ ″	Authority.
Argelander's Zones 145, 126	8.9	2 2 12.32	+48 53 14.90	
" " 151, 111	8.9	2 2 59.67	49 4 27.64	
Groombridge 466	7	2 3 32.53	+52 21 7.23	Radcliffe Observations.

I am indebted to Dr. Petersen for the following European observations of this comet: —

1852.	Altona M. T. h. m. s.	☄ α ° ′ ″	☄ δ ° ′ ″	
Aug. 10	12 55 50.1	22 52 32.5	+14 27 5.4	9
12	13 18 32.4	23 26 23.7	+16 28 23.4	0

Mean places of comparison-stars: —

α 1852.0. h. m s.	Red. s.	δ 1852.0. ° ′ ″	Red. ″	Authority.
1 31 58.25	+1.47	+14 30 25.0	+6.5	Weisse I. 507, 508.
1 30 57.51	+1.54	+16 28 19.0	+6.2	B. Z. 394.

1852.	Berlin M. T. h. m. s.	☄ α ° ′ ″	☄ δ ° ′ ″	No. Comp.	*
July 29	13 25 53.2	19 26 36.5	+ 4 26 8.3	6	*a*
Aug. 7	11 32 45.8	22 0 35.1	11 34 30.4	15	*b*
12	12 6 32.8	23 25 12.0	+16 24 56.4	12	*c*

Apparent places of comparison-stars: —

a	19° 17′ 3″.8	+ 4° 24′ 22″.1	B. Z. 116
b	22 3 40.1	11 35 47.3	" 124
c	23 57 6.3	+16 22 35.2	" 394.

Elements and ephemeris by **Sonntag**, computed with due regard to the influence of aberration and parallax, from observations at Berlin, July 29 and August 7, and Altona, August 16.

T	1852, October 11.35920 M. T. Berlin.	
π	42° 47′ 4″.9	Mean Equinox, August 1.
☊	346 44 30.9	
i	41 39 36.7	
Log. q	0.1015642	
	Direct.	

The middle observation gives: —

C. — O.

$\Delta\lambda = -31''.8 \qquad \Delta\beta = +1''.3$

Ephemeris for Mean Berlin Midnight.

1852.	☄ α	☄ δ	Log. △
Sept. 1	29° 5′.8	+42° 34′.4	9.8145
2	29 24.1	44 8.1	
3	29 42.6	45 42.6	
4	30 1.5	47 18.0	
5	30 20.8	48 54.0	9.8025
6	30 40.5	+50 30.4	
Sept. 7	31° 0′.6	+52° 7′.0	
8	31 21.4	53 43.6	
9	31 42.8	55 20.1	9.7959
10	32 4.8	56 56.4	
11	32 27.7	58 32.4	
12	32 51.4	60 7.9	
13	33 16.3	61 42.7	9.7942
14	33 42.4	63 16.6	
15	34 10.1	64 49.6	
16	34 39.7	66 21.5	
17	35 11.4	67 52.2	9.7977
18	35 45.6	69 21.5	
19	36 22.9	70 49.3	
20	37 4.0	72 15.6	
21	37 49.3	73 40.2	9.8055
22	38 39.6	75 2.8	
23	39 36.7	76 23.6	
24	40 43.5	77 42.6	
25	42 1.7	+78 59.6	9.8168

G.

MELPOMENE.

Observations at the Berlin Observatory by Dr. **Brünnow** and Mr. G. **Rümker**, communicated by Dr. **Petersen**.

1852.	h. m. s.	⑱ α	⑱ δ	No. Comp.	*
June 29	11 0 51.0	271° 58′ 11″.2	—8° 30′ 1″.8	12	*a*
30	10 44 14.9	271 42 42.7	8 33 25.6	12	*a*
30	11 18 14.9	271 42 19.1	8 33 29.6	8	*a*
July 1	11 13 31.8	271 26 41.8	8 37 5.4	9	*a*
2	11 2 46.0	271 11 15.3	8 40 48.4	8	*a*
2	11 40 34.6	271 10 48.3	8 40 51.0	10	*b*
3	10 32 48.7	270 56 6.3	8 44 36.2	12	*b*
4	11 6 4.6	270 40 20.1	8 48 46.5	10	*b*
5	10 36 11.7	270 25 17.6	8 52 0.1	4	*b*
6	11 52 47.8	270 9 38.9	8 57 34.0	9	*c*
8	11 12 58.2	269 40 26.8	9 6 43.9	7	*d*
9	10 48 52.6	269 26 18.5	9 11 27.8	12	*d*
10	11 12 37.0	269 11 48.2	9 16 35.9	10	*e*
11	10 44 52.8	268 58 6.8	9 21 38.2	15	*e*
13	10 56 26.5	268 30 58.7	9 32 18.0	10	*f*
14	11 39 34.6	268 17 28.3	9 38 0.8	10	*g*
15	11 11 18.3	268 4 57.6	9 43 36.5	10	*g*
16	11 16 20.0	267 52 31.7	9 49 25.2	10	*g*
17	11 12 27.6	267 40 40.7	9 55 24.6	8	*g*
29	10 57 13.0	265 47 43.3	11 14 11.7	10	*h*
31	11 16 56.9	265 35 8.3	11 28 28.9	4	*i*
Aug. 4	10 56 52.1	265 16 19.8	—11 57 27.5	12	*k*

Apparent Places of Comparison-Stars.

		✱ α	✱ δ	
June 29	*a*	271° 52′ 20″.1	−8° 31′ 41″.8	B. Z. 255.
30	*a*	20.2	41.8	
July 1	*a*	20.3	41.7	
2	*a*	20.4	41.6	
2	*b*	270 59 32.7	8 45 29.5	B. Z. 255, 256,
3	*b*	32.8	29.5	and
4	*b*	32.9	29.4	Santini, IV. 354, V. 384.
5	*b*	33.0	29.3	
6	*c*	270 21 31.5	8 47 28.9	2 Mer. Obs., Hamburg.
8	*d*	269 52 9.3	9 11 22.7	4 " "
9	*d*	9.4	22.7	
10	*e*	268 57 12.2	9 15 1.0	2 " "
11	*e*	12.4	0.9	
13	*f*	268 3 37.3	9 29 49.0	4 Mer. Obs., Hamb. and Berlin.
14	*g*	267 43 42.7	9 41 59.2	ν Ophiuchi ; B. A. C. 6078.
15	*g*	42.7	59.2	
16	*g*	42.8	59.1	
17	*g*	42.8	59.1	
29	*h*	266 28 45.3	11 18 3.4	B. A. C. 6054.
31	*i*	266 40 28.2	11 35 58.0	Piazzi 17275 ; Taylor 8279.
Aug. 4	*k*	265 32 2.7	−12 6 38.9	B. Z. 257 ; Lalande 32550.

Elements and Ephemeris of *Melpomene*, computed by **Schönfeld** and **Thormann** in Bonn, from observations, London, June 24, and Bonn, July 16 and August 12.

Epoch, 1852, July 0, M. T. Berlin.

M	284° 24′ 33″.97	
π	15 10 57.10	Mean Equinox of epoch.
☊	149 57 53.72	
i	10 9 38.04	
ϕ	12 33 45.70	
Log. a	0.3612018	
" μ	3.0082039	

These elements represent the middle observation thus:—

C. — O.

$$\Delta\lambda = +0''.03 \qquad \Delta\beta = +0''.05$$

Ephemeris for Mean Berlin Midnight.

1852.	α h. m. s.	δ ° ′	Log. △
Sept. 15	17 59 56	−16 59.2	
16	18 1 2	17 5.3	
17	2 9	11.4	0.23846
18	3 18	17.4	
19	4 28	23.3	
20	5 40	29.2	
21	6 53	34.9	0.24739
22	8 8	40.5	
23	9 24	46.1	
24	10 42	51.6	
25	12 1	17 56.9	0.25614
26	13 21	18 2.2	
27	18 14 43	−18 7.3	
Sept. 28	18 16 6	−18 12.4	
29	17 30	17.4	0.26471
30	18 55	22.2	
Oct. 1	20 22	27.0	
2	21 50	31.6	
3	23 20	36.1	0.27309
4	24 51	40.6	
5	26 22	44.9	
6	27 55	49.1	
7	29 29	53.1	0.28127
8	31 5	18 57.1	
9	32 41	19 1.0	
10	34 19	4.7	
11	35 58	8.3	0.28922
12	37 38	11.8	
13	39 19	15.2	
14	41 1	18.4	
15	42 44	21.5	0.29696
16	44 28	24.5	
17	46 13	27.4	
18	47 59	30.1	
19	49 46	32.7	0.30446
20	51 34	35.2	
21	53 23	37.5	
22	55 13	39.7	
23	57 4	41.8	0.31172
24	18 58 56	43.7	
25	19 0 49	45.5	
26	19 2 42	−19 47.2	

1852.	α	δ	Log. Δ	1852.	α	δ	Log. Δ
	h. m. s.	° ′			h. m. s.	° ′	
Oct. 27	19 4 37	—19 48.7	0.31874	Nov. 7	19 26 27	—19 55.9	
28	6 32	50.1		8	28 31	55.6	0.33845
29	8 28	51.3		9	30 35	55.3	
30	10 25	52.4		10	32 40	54.8	
31	12 23	53.3	0.32554	11	34 46	54.1	
Nov. 1	14 21	54.1		12	36 52	53.3	0.34454
2	16 20	54.8		13	38 59	52.4	
3	18 20	55.3		14	41 6	51.3	
4	20 21	55.7	0.33210	15	43 14	50.0	
5	22 22	55.9		16	19 45 23	—19 48.6	0.35042
6	19 24 24	—19 56.0					

OBSERVATIONS OF MELPOMENE.

By PROFESSOR CHARLES RÜMKER.

Date.	M. T. Hamburg.	⑱ α	Par.	⑱ δ	Par.	Observations.
	h. m. s.	° ′ ″	″	° ′ ″	″	
June 28	12 7 31.8	272 12 50.7	+0.5	—8 27 5.3	+4.9	10 Comparisons.
30	10 16 50.5	271 42 43.4	—1.3	8 33 24.1	4.9	3 "
July 2	12 42 27.7	271 10 1.8	+1.5	8 41 1.9	4.9	15 "
3	12 0 24.3	270 54 58.0	+0.8	8 44 52.4	4.9	19 "
4	10 26 39.1	270 40 40.4	—1.0	8 48 44.1	4.9	9 "
4	11 10 21.9	270 25 3.2	0.0	8 48 50.9	6.1	Meridian-Circle.
5	10 20 16.3	270 25 27.1	—1.0	8 52 53.5	4.9	14 Comparisons.
5	11 5 25.8	270 25 3.2	0.0	8 53 5.8	6.1	Meridian-Circle.
6	11 0 30.0	270 10 2.0		8 57 26.8	6.1	"
7	10 55 34.9	269 55 12.2		9 2 1.0	6.1	"
8	10 50 40.8	269 40 36.4		9 6 41.7	6.1	"
9	10 45 47.1	269 26 8.8		9 11 29.8	6.0	"
10	10 40 55.0	269 12 3.5				
11	10 36 3.5	268 58 6.8		9 21 36.7	6.0	"
12	10 31 13.7	268 44 27.7		9 26 53.1	6.0	"
14	10 21 37.6	268 18 4.0		9 37 50.3	6.0	"
15	10 16 49.0	268 5 14.3		9 43 28.1	6.0	"
16	10 12 3.7	267 52 52.5		9 49 15.4	6.0	"
17	10 7 19.4	267 40 43.4		9 55 9.6	6.0	"
20	9 53 16.8	267 6 54.0		10 13 36.1	6.0	"
22	9 44 2.7	266 46 17.9		10 26 16.9	6.0	"
23	9 39 27.9	266 36 35.4		10 32 49.9	5.9	"
24	9 34 55.4	266 27 21.5		10 39 23.8	5.9	"
25	10 40 53.0	266 18 9.2	+1.2	10 46 32.8	4.6	14 Comparisons.
26	9 25 54.9	266 10 9.4		10 52 57.0	5.9	Meridian-Circle.
26	10 20 15 5	266 9 56.0	+1.2	10 53 12.0	4.5	13 Comparisons.
28	9 17 2.4	265 54 56.4		11 6 50.0	5.9	Meridian-Circle.
29	9 12 38.8	265 48 1.5		11 13 41.4	5.9	"
30	9 18 17.2	265 41 33.8		11 20 55.9	5.8	"
30	10 18 29.9	265 41 27.8	+1.2	11 21 4.5	4.5	6 Comparisons.
Aug. 1	8 59 39.8	265 30 8.3		11 35 8.3	5.8	Meridian-Circle.
2	10 26 42.6	265 25 0.6	+1.5	11 42 44.2	4.4	4 Comparisons.
4	9 28 39.9	265 16 30.4	+0.7	11 57 0.1	4.3	10 "
7	9 11 42.4	265 7 32.4	+0.6	—12 19 5.4	+4.0	4 "

Mean Places for January 0, 1852, *of Fixed Stars in the Geocentric Orbit of Melpomene, ascertained with the Meridian-Circle.*

Mag.	Mean R.A. Jan. 0, 1852.	No. of Obs.	Mean Decl. Jan. 0, 1852.	No. of Obs.	Mag.	Mean R.A. Jan. 0, 1852.	No. of Obs.	Mean Decl. Jan. 0, 1852.	No. of Obs.
	h. m. s.		° ′ ″			h. m. s.		° ′ ″	
9	17 30 11.675	2	—12 16 26.6	2	9	17 49 45.212	1	—9 18 8.9	1
9	33 41.049	1	13 51 36.8	1	9	52 12.479	3	9 29 51.0	3
9	36 0.455	1	12 8 15.1	1	9	51 8.925	1	10 29 56.0	1
8.9	36 8.415	2	12 58 29.0	2	(8)	55 46.872	2	9 15 4.2	1
9	37 25.066	4	11 30 42.8	4	8	56 17.001	1	9 15 46.4	1
8	37 39.829	2	10 17 17.2	2	9	57 2.758	1	9 31 49.2	1
8	37 59.511	2	13 14 35.4	2	8	57 37.313	4	9 16 3.1	3
8	38 0.315	1	13 14 24.0	1	8	17 59 26.765	5	9 11 25.2	5
8	40 28.153	2	10 12 51.8	2	8	18 1 36.178	3	8 47 30.4	3
9	40 50.349	3	11 17 4.0	1	7	3 56.228	2	8 45 31.4	2
8.9	41 14.696	2	10 42 53.7	2	9	5 37.228	1	9 54 24.1	1
8.9	41 34.698	2	10 25 17.0	2	(10)	6 13.843	1	8 43 50.5	1
9	42 5.915	2	12 6 40.9	1	9	6 19.715	1	8 11 42.5	1
8.9	43 51.561	2	9 56 3.6	2	8.9	7 26.913	7	8 31 42.0	7
(7)	44 50.101	2	10 51 29.6	2	8	10 3.348	2	8 41 4.8	2
(8)	45 1.102	1	10 19 43.0	1	9	12 3.637	1	8 36 24.3	1
(7)	45 52.942	4	11 18 4.7	2	(9.10)	13 22.719	7	8 20 45.8	7
(7)	48 16.469	1	10 19 42.2	1	6	18 25.164	1	8 15 57.8	1
9	17 48 20.115	1	— 9 35 9.3	1	9	18 19 2.989	1	—8 57 39.4	1

NINETEENTH ASTEROID.

Mr. **Hind** writes that on August 22, 11h. 30m., he discovered still another new planet, resembling a star of the 9 magnitude. His observations gave,

1852.	Greenwich M. T.	R.A.	N.P.D.
	h. m. s.	h. m. s.	° ′ ″
Aug. 22	11 35 39	22 22 29.74	97 32 14.1
	12 27 16	27.88	25.2

Dr. **Petersen** has sent me the following Continental observations:—

1852.	M. T. Göttingen.	α	δ	
	h. m. s.	° ′ ″	° ′ ″	
Aug. 27	11 52 45.64	334 31 37.65	7 59 45.7	M. C.
	13 50 1.4	334 30 29.25	8 0 11.7	R. M.

1852.	M. T. Bonn.	α	δ	
	h. m. s.	° ′ ″	° ′ ″	
Aug. 27	9 36 44.8	334 32 49.0	7 59 18.8	8 Comp.
	10 44 42.9	334 32 13.1	7 59 32.1	7 "

1852.	M. T. Berlin.	α	δ	
	h. m. s.	° ′ ″	° ′ ″	
Aug. 28	10 59 6.9	334 18 55.3	8 5 6.6	Refractor.
	11 48 0.5	334 18 26.1	8 5 17.8	Mer. Cir.

This planet has also been observed by Mr. **Ferguson** at the Washington Observatory, who found

1852.	M. T. Washington.	No. of Comp.	Comparison-Star.	⑲ — ∗		⑲'s apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
	h. m. s.			m. s.	′ ″	h. m. s.	° ′ ″
Sept. 13	8 37 11.4	1	Weisse XXII. 13	+2 18.65	—1 34.24	22 4 1.50	—9 32 50.28
	10 8 14.2	6	"	+2 15.66	—1 51.43	22 3 58.51	—9 33 7.16

Mr. **Ferguson** estimated the planet as of the 8.6 magnitude. The adopted mean place for 1850.0 of the comparison-star was, Weisse XXII. 13, $\alpha = 22^{h.}\ 1^{m.}\ 34^{s.}.13$; $\delta = 9°\ 32'\ 3''.20$.

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